REFINEMENT OF BIOLOGICAL METRICS IN THE DEVELOPMENT OF BIOLOGICAL CRITERIA FOR REGIONAL BIOMONITORING AND ASSESSMENT OF SMALL STREAMS IN IDAHO

1991-1992

FINAL REPORT

Prepared by

Christopher T. Robinson and G. Wayne Minshall

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Department of Biological Sciences
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SUMMARY

The primary goal of the project was to refine and test a series of biotic metrics for assessing biological integrity to eventually develop biological criteria for demonstrating recovery or degree of impact for freshwater ecosystems. A standardized methodology proved effective for comparing and combining data from the previous year of study. We found a quantitative sample (modified Hess sampler, 250-μm mesh) to be as fast and provide additional information for macroinvertebrates (e.g., organism density and biomass) and better resolution among stream types than a qualitative kick sample. In addition, a single pass of the electrofisher was effective for fish in streams with low turbidity and low fish densities, but a three-pass approach was needed when streams were turbid and/or had high fish densities.

The addition of some quantitative variables (e.g., maximum water temperature, nitrate and phosphorus levels) for assessing aquatic habitats were important or useful in distinguishing between ecoregions and among stream types. Seven metrics for macroinvertebrates (EPT richness, H' diversity, %EPT, HBI, Simpson's Index, % dominance, and % Filterers) were found important for distinguishing among stream types for the two ecoregions. Six metrics for fish were found important for distinguishing among-stream types between the two ecoregions. These metrics focused primarily on the Salmonidae assemblage or degree of tolerant taxa in the fish assemblage. The data suggest the current refined biotic metrics are suitable for monitoring biological integrity for streams in the Northern Basin and Range and Snake River Plain ecoregions.

INTRODUCTION

Rapid bioassessment has become an important tool in assessing the biological integrity of freshwater systems (Plafkin et al. 1989, Karr et al. 1986, Karr 1991). Rapid bioassessment attempts to combine quantitative aspects of water quality with qualitative biological conditions using a regional approach (Hughes et al. 1990). The regional approach provides a methodology for assessing biological intergrity and facilitating the development of recovery criteria among different ecoregions. Numerous states have adopted an ecoregion approach for assessing biological conditions (e.g. Fausch et al. 1984, Gallant et al. 1989). Indeed, the state of Idaho recently drafted a number of monitoring protocols for assessing biological integrity using both fish (Chandler and Maret 1991) and macroinvertebrates (Clark and Maret 1991) in conjunction with habitat evaluation guidelines (Burton 1991, Burton et al. 1991). The present study incorporated rapid bioassessment protocols for evaluating the biological integrity of two ecoregions, the Northern Basin and Range and Snake River Plain, located within Idaho.

The overall goal of this project was to further develop and test a biological assessment program for small (2nd-4th order) streams in the Snake River Plain (SRP) and Northern Basin and Range (NBR) ecoregions of southern Idaho (Robinson and Minshall 1991). Specific objectives were fourfold:

(1) To establish an initial reference data base from a spectrum of "least" impacted or disturbed stream habitats in the two ecoregions;

(2) To demonstrate the utility of the ecological assessment approach by comparing biological conditions in environmentally impacted streams with conditions in reference streams;

(3) To examine a variety of biotic metrics used to assess biological integrity and determine their applicability to conditions found in the Snake River Plain and Northern Basin and Range ecoregions; and

(4) To determine if reference streams differ significantly between the two ecoregions.

Reference streams were partitioned to cover both upland (wooded-high gradient) and lowland (low gradient) habitat types. Impacted streams used for validation were anthropogenically perturbed locations representative of the major land use practice in the area: livestock grazing. Special effort was made to select designated "stream segments of concern" (Clark 1990, Dunn 1990). An additional objective of this project was to develop a standardized field collection methodology for use by resource managers in biomonitoring.

METHODS

Selection of Study Sites

Study sites were selected from candidate streams by reviewing existing literature concerning site conditions, discussions with various agency personnel (Bureau of Land Management, Idaho Division of Environmental Quality, Idaho Department of Fish and Game, and United States Forest Service) and private land owners, and by field reconnaissance (Table 1). Maps of specific site locations are included in this report as Appendix A. Thirty-nine of 70 streams examined during the summers of 1990 and 1991 were selected for field sampling and data analysis.

Stream types analyzed included upland, lowland, and impacted lowland sites on small 2nd-4th order streams (Strahler 1957).

Table 1. Specific locations of study sites examined by field reconnaissance and for calculations (*).

STREAM	7.5 TOPOGRAPHIC	COUNTY	LONGITUDE	LATITUDE	TOWNSHIP	RANGE	SECTION	ELEVATION
*Green	Elba	Cassia	113°43'	42°15'	T14S	R24E	11	1772
*Stinson	Cache Peak	Cassia	113°40'	42°15'	T13S	R24E	33	1848
*Trapper	Severe Springs	Cassia	114°08'	42°10'	T15S	R20E	10	1612
*Buck	Dish Pan	Owyhee	115°25'	42°00'	T16S	R09E	28	1590
*Cottonwood	O'connor Ridge	Cassia	113°40'	42°15'	T13S	R24E	23	1500
Goose (Upper)	Timber Butte	Cassia	114°15'	42°05'	T15S	R19E	31	1848
Six Mile	Strevell	Cassia	113°10'	42°07'	T15S	R28E	16	1757
*Rock (3rd Fork)	Grandview Peak	Cassia	114°15'	42°15'	T13S	R19E	32	1575
Rock (4th Fork)	Grandview Peak	Cassia	114°15'	42°15'	T13S	R19E	32	1575
Big Cottonwood	Buckhorn Canyon	Cassia	114°05'	42°15'	T13S	R21E	30	1515
Ef Jarbridge	Murphy Hot Springs	Owyhee	115°20'	42°00'	T16S	R09E	25	1590
Trout	Mahogany Butte	Cassia	114°10'	42°05'	T16S	R19E	12	1818
Eight Mile	Sandrock Canyon	Cassia	113°10'	42°10'	T15S	R28E	4	1757
Cold	Blue Hill	Cassia	113°55'	42°07'	T15S	R22E	21	1727
*Little Jack's	Bighorse Basin Gap	Owyhee	116°00'	42°35'	T08S	R03E	16	1072
*Lake Fork	Sublett	Cassia	113°02'	42°20'	T12S	R29E	34	1634
*Station Fork	Sublett	Cassia	113°00'	42°20'	T13S	R29E	1	1636
*Cottonwood	Hill Pasture	Owyhee	116°05'	42°32'	T10S	R03E	27	1455
*Big Jack's (Upper)	Hill Pasture	Owyhee	116°02'	42°35'	T10S	R04E	18	1333
Vinyard	Kimberly	Jerome	114°20'	42°35'	T10S	R18E	4	1067
Salmon Falls	Roseworth Ne	Twin Falls	114°50'	42°25'	T11S	R14E	19	1136
Devil's Corral	Kimberly	Jerome	114°20'	42°35'	T09S	R18E	32	1030

Table 1 (cont.)

STREAM	7.5 TOPOGRAPHIC	COUNTY	LONGITUDE	LATITUDE	TOWNSHIP	RANGE	SECTION	ELEVATION
Sand Springs	Thousand Springs	Gooding	114°50'	42°37'	T08S	R14E	17	939
Dove	Taylor Canyon	Twin Falls	114°55'	42°05'	T15S	R13E	26	20120
*Sheep	Triguero Lake	Owyhee	115°45'	42°15'	T14S	R06E	15	1467
*Big Jack's (Lower)	Wickahoney Cross	Owyhee	116°00'	42°35'	T10S	R04E	4	1242
*Cassia	O'connor Ridge	Cassia	113°30'	42°15'	T13S	R25E	22	1500
*Mary's	Buckhorn	Owyhee	115°55'	42°10'	T14S	R04E	27	1730
Duncan	Hill Pasture	Owyhee	116°00'	42°34'	T10S	R04E	19	1364
*Duncan 2	Hill Pasture	Owyhee	116°04'	42°31'	T10S	R03E	36	1482
*Shoshone	Magic Hot Springs	Twin Falls	114°30'	42°02'	T16S	R16E	24	1636
Deep	Buhl	Twin Falls	114°50'	42°35'	T10S	R14E	8	1121
*Deep 2	Slack Mountain	Owyhee	116°41	42°35	T10S	R03W	3	1580
Goose (Lower)	Blue Hill	Cassia	113°55'	42°05'	T15S	R22E	31	1467
*Trapper (Lower)	Severe Springs	Cassia	114°03'	42°10'	T15S	R21E	6	1539
Billingsley	Tuttle	Gooding	114°50'	42°50'	T07S	R14E	19	909
*Mink	Oneida Narrow Resevoir	Franklin	111°39'	42°16'	T13S	R41E	22	1647
*Bloomington	Paris	Bear Lake	111°30'	42°11'	T14S	R42E	23	1891
*W F Mink	Clifton Creek	Bannock	112°26'	42°44'	T08S	R34E	13	1647
*Timber	Iron Creek Point	Custer	113°26'	44°25'	T13N	R25E	25	2330
*S F Soldier	Phillips	Camas	114°50'	43°30'	T02N	R14E	19	1848
*Cherry	Galena	Blaine	114°38'	43°51'	T06N	R15E	14	2190
*Bear	Copper Basin	Custer	113°56'	43°45'	T05N	R21E	22	717
*Ramey	Copper Basin	Custer	113°56'	43°49'	T06N	R21E	27	640
*Coyote	Galena	Blaine	114°39'	43°51	T06N	R15E	15	2199

Table 1 (cont.)

STREAM	7.5 TOPOGRAPHIC	COUNTY	LONGITUDE	LATITUDE	TOWNSHIP	RANGE	SECTION	ELEVATION
•Big Willow	Squaw Butte	Payette	116°28'	44°05'	T09N	R01W	29	909
•Cold Springs	Goodman Flat	Gooding	115°21'	43°08'	T03S	R03S	26	1183
•Current	Slack Mountain	Owyhee	116°45'	42°35'	T09S	R03W	31	1617
•Spring	Riley Butte	Washington	116°25'	44°21'	T12N	R01W	24	1049
•S F Mink	Clifton Butte	Bannock	112°25'	42°41'	T08S	R35E	31	1769
•Wolverine	Wolverine	Bingham	111°12'	43°17'	T02S	R39E	6	1678
•Camas	Spring Creek Resevior	Camas	114°39'	43°19'	T01S	R15E	22	1501
•Rock (Magic)	Richardson Summit	Blaine	114°24'	43°26	T01N	R17E	11	1571
•Rock (Twin) S-5	Stricker Butte	Twin Falls	114°21'	42°27'	T11S	R18E	23	1220
•Rock (Twin) S-6	Grand View Peak	Twin Falls	114°18'	42°21'	T12S	R18E	24	1332
•Rock (Twin) S-8	Grand View Peak	Cassia	114°14'	42°17'	T13S	R19E	17	1525
Soldier	Phillips	Camas	114°50'	43°30'	T02N	R14E	19	1848
Soldier (above S F)	Phillips	Camas	114°50'	43°30'	T02N	R14E	19	1848
Willow	Macon	Camas	114°30'	43°20'	T01S	R16E	3	1495
Portneuf	Chesterfield	Caribou	112°00'	42°50'	T07S	R37E	26	1610
Birch	Mink Creek	Franklin	111°40'	42°15'	T13S	R41E	9	1708
Newman	Easley Hot Springs	Blaine	114°40'	43°51'	T06N	R15E	15	2196
Webber	Heart Mountain	Clark	112°40'	44°25	T12N	R09W	15	2074
Iron	Iron Creek Point	Custer	113°25'	43°25'	T12N	R25E	12	2245
W F Star Hope	Copper Basin	Custer	113°56'	43°45'	T05N	R21E	22	763
W F Shoofly	Snow Creek	Owyhee	116°16'	42°45'	T08S	R01E	13	1373
Clover	Davis Mountain	Gooding	114°55'	43°10'	T03S	R13E	19	1513

Table 1 (cont.)

STREAM	7.5 TOPOGRAPHIC	COUNTY	LONGITUDE	LATITUDE	TOWNSHIP	RANGE	SECTION	ELEVATION
Nip & Tuck	Wickiup Creek	Owyhee	$116^{\circ}40'$	$42^{\circ}40'$	T09S	R03W	27	1830
Shoofly	Ox Lake	Owyhee	$116^{\circ}14'$	$42^{\circ}45$	T08S	R02E	9	1281
Corral	Corral	Camas	$114^{\circ}50;$	$43^{\circ}20'$	T01S	R13E	21	1548

Note. 7.5 topographic quad maps, and elevation in meters.

Upland sites were characterized as having greater slopes, more turbulent flow, and being higher in elevation than lowland sites. The impacted sites were representative of lowland areas perturbed primarily by livestock grazing and other nonpoint source agricultural inputs; impacted streams served for metric validation. The 39 sites analyzed were comprised of 16 (11 in SRP, 5 in NBR) upland, 10 (8 in SRP, 2 in NBR) lowland, and 13 (9 in SRP, 4 in NBR) impacted lowland streams. The number of sites examined in detail were limited by budgetary constraints. The unbalanced sample sizes were largely the result of an administrative decision to emphasize initially SRP streams and by the difficulty in locating satisfactory lowland reference sites.

Field reconnaissance provided an important avenue for final selection of study sites from candidate streams. A two-part habitat assessment data sheet was used during field reconnaissance (Table 2). The first page provided for detailed information on physical and chemical characteristics (e.g., stream slope, elevation, width/depth ratio, mean width, % canopy cover, land-use, vegetative characteristics, discharge (Platts et al. 1983), riparian conditions, substrate measures, water temperature, pH, specific conductance, alkalinity, and turbidity) for a site. The second part included a habitat assessment field survey which allowed for the tally of an overall habitat score based upon the qualitative ranking of 12 categories (based from Plafkin et al. 1989, Barbour and Stribling in press, Clark and Maret 1991). The habitat assessment field data sheet currently involves categories based upon prevailng habitat conditions, i.e., whether a site consists predominantly of riffle/run or glide/pool conditions (Table 2). Categories were modified to take into account these prevailing habitat conditions of a site.

Onsite field reconnaissance and habitat assessment generally required about three person-hours per stream once at the site. Initial logistic planning in the laboratory using 1:100,000-scale

Table 2. Habitat evaluation field data sheet.

IDAHO ECOREGION - HABITAT ASSESSMENT FIELD DATA SHEET

ECOREGION:______________________________

STREAM/TYPE:____________________________

DATE/RECORDER:__________________________

GENERAL PHYSICAL CHARACTERISTICS

STREAM ORDER:

STREAM SLOPE:

SITE ELEVATION:

DISCHARGE:

LAND-USE

ADJACENT TO STREAM:

WATERSHED:

IN-STREAM VEGETATION:

RIPARIAN VEGETATION:

WATERSHED VEGETATION:

BANK EROSION PRESENT:

NPS POLLUTION EVIDENT:

STREAM WIDTH:_____,_____,_____,_____,_____

DEPTH: (1)____,____,____,____,____,____,____,____,____,____

(2)____,____,____,____,____,____,____,____,____,____

(3)____,____,____,____,____,____,____,____,____,____

(4)____,____,____,____,____,____,____,____,____,____

(5)____,____,____,____,____,____,____,____,____,____

VELOCITY:____,____,____,____,____,____,____,____,____,____

PROP #,TIME:______,_______

PERCENT CANOPY COVER:

RIPARIAN ZONE WIDTH: rt bk____,____,____ lft bk____,____,____

PREDOMINANT SUBSTRATE:a-axis____,____,____ b-axis____,____,____

WATER QUALITY

TEMPERATURE:

ALKALINITY:

pH:

CONDUCTIVITY:

TURBIDITY:

HARDNESS:

NITROGEN:

WEATHER CONDITIONS:

PHOTOGRAPH NUMBER:

COMMENTS

ACCESSIBILITY:

LOCATION:

OWNERSHIP:

Table 2. (cont.)

HABITAT ASSESSMENT FIELD DATA SCORING SHEET

ECOREGION:____________________

STREAM/TYPE:____________________ SCORE________

DATE/RECORDER:____________________

RIFFLE/RUN (UPLAND)	GLIDE/POOL (LOWLAND)
1. SUBSTRATE/COVER	1. SUBSTRATE/COVER
2. EMBEDDEDNESS	2. POOL SUBSTRATE TYPE
3. FLOW/VELOCITY	3. POOL VARIABILITY
4. CANOPY COVER	4. CANOPY COVER
5. CHANNEL ALTERATION	5. CHANNEL ALTERATION
6. BOTTOM SCOURING AND DEPOSITION	6. DEPOSITION
7. POOL/RIFFLE or RUN/BEND RATIO	7. CHANNEL SINUOSITY
8. WIDTH/DEPTH RATIO	8. WIDTH/DEPTH RATIO
9. UPPER BANK STABILITY	9. UPPER BANK STABILITY
10. BANK VEGETATION	10. BANK VEGETATION
11. STREAMSIDE COVER	11. STREAMSIDE COVER
12. RIPARIAN WIDTH	12. RIPARIAN WIDTH

RANKINGS:

PARAMETER	EXCELLENT	GOOD	FAIR	POOR
1-4	16-20	11-15	6-10	0-5
5-8	12-15	8-11	4-7	0-3
9-12	9-10	6-8	3-5	0-2

planimetric maps made field reconnaissance more efficient. This procedure was emphasized due to the often remote nature and widely separated locations of field sites. For example, field site locations ranged from the Idaho/Wyoming border to the Idaho/Oregon border and often were accessible via a dirt track or by foot. However, some sites were examined on an impromptu basis while en route to a scheduled site. We recommend that field crews also complete a habitat assessment field data sheet at the time of sampling if habitat conditions change since time of field reconnaissance.

Refinement of the Habitat Assessment Procedure

Other quantitative measures of habitat conditions were recorded at each sampled site in addition to the physical and chemical measures listed above (Table 3). These measures included a width/depth ratio and mean width averaged from five channel transects each 30m apart, % canopy cover, periphyton chlorophyll a and ash-free-dry-mass (AFDM)(n=5), total hardness, nitrate, ortho-phosphate, substrate size and embeddedness (n=100), and amount of benthic organic matter (BOM). Nitrate and ortho-phosphate was measured in the field using a HACH kit. Benthic organic matter was quantified from material obtained with the benthic macroinvertebrate samples. Following macroinvertebrate processing, organic matter was determined by drying the sample at 60 °C for 48 h, weighing, ashing at 550 °C for 2 h, rehydrating, redrying for 24 h, and reweighing. The difference in dry weights is the quantity of organic matter (as AFDM) for that sample.

Periphyton was collected by scraping a known area from the surface of a stone and collecting the material onto a Whatman GF/F glass fiber filter (see Robinson and Minshall 1986). Upon filtering, the material was kept frozen until analysis in the

Table 3. Summary of habitat measures recorded for each study site. Data for Rock Creek (Twin) sites from Idaho DEQ.

STATION	#	LOC	TYPE	DATE	ELEV (m)	WIDTH/ DEPTH RATIO	MEAN WIDTH (m)	AREA SHOCKED (m-2)	% COVER	AFDM (g/cm2)	CHL-a (ug/cm	Q (m3/s)	TEMP (C)	SPEC. COND. (umhos)	ALKA (mg/L) (CaCO3)	TOTAL HARD	pH	NO3 (mg/L)	PO4 (mg/L)	SUBSTRATE CV	SUBSTRATE AVG	EMBEDDEDNESS AVG (%)	EMBEDDEDNESS CV (%)	SLOPE	BOM AFDM
Green	1	NBR	UP	1990	1772	15.9	2.8	280	65	0.000	0.221	0.12	10.0	22	10	42	7.3			0.66	28.4			12.0	54.6
Stinson	2	NBR	UP	1990	1848	13.1	2.2	66	80	0.000	0.329	0.10	13.6	27	14	40				0.76	6.4			9.0	23.5
Cottonwood	5	NBR	UP	1990	1500	21.8	2.9	145	30	0.000	0.176	0.10	14.3	59	35	40	7.9			1.28	15.7			1.0	81.2
Trapper	3	NBR	UP	1990	1612	18.5	3.7	130	1	0.001	1.022	0.36	16.7	151	109	139	8.0			0.66	5.5	27	1.01	2.0	23.7
Bloomington	35	NBR	UP	1991	1891	17.4	4.1	202	50	0.004	0.130	0.38	6.3	391	166	167	8.6	0.08	0.07	1.13	22.3	39	0.84	7.0	18.3
Mink	36	NBR	UP	1991	1647	37.3	6.0	240	20	0.150	0.190	0.16	15.0	317	165	200	8.7	0.24	0.06	0.78	19.5	36	0.84	6.0	13.4
WF Mink	37	NBR	UP	1991	1800	17.1	2.3	30	60	0.010	1.650	0.12	16.2	391	196	190	8.7	0.01	0.13	1.33	4.4	59	0.61	4.5	15.8
3rd Fork	8	NBR	UP	1990	1575	29.4	5.4	189	50	0.001	0.009	0.12	9.0	78	68	90	7.6			0.94	20.8	31	0.87	2.0	25.1
Timber	38	SRP	UP	1991	2546	18.9	2.9	208	60	0.002	0.379	0.05	9.5	160	46	40	8.4	0.03	0.11	0.90	16.9	26	1.11	3.0	10.3
SF Soldier	39	SRP	UP	1991	2020	22.9	4.6	270	75	0.003	0.200	0.24	7.2	39	10	11	7.9	0.07	0.09	0.47	19.6	22	1.32	4.0	2.9
Buck	4	SRP	UP	1990	1590	14.3	3.5	88	50	0.001	3.520	0.03	15.2	137	105	121				0.74	10.5			9.0	17.1
Cherry	40	SRP	UP	1991	2393	18.9	1.8	91	45	0.002	0.373	0.08	14.0	142	67	75	8.6	0.03	0.01	0.68	14.2	21	1.30	3.5	8.7
Bear	41	SRP	UP	1991	717	17.9	2.9	90	90	0.002	0.781	0.13	10.5	82	12	15	8.0	0.03	0.04	1.24	13.9	42	0.99	0.5	10.7
Ramey	42	SRP	UP	1991	640	10.5	2.2	109	60	0.002	1.789	0.17	7.5	95	25	27	8.4	0.07	0.06	0.94	24.1	13	1.49	14.0	25.1
Coyote	43	SRP	UP	1991	2403	19.8	2.2	109	75	0.001	0.284	0.07	12.0	68	36	35	8.1	0.04	0.01	1.03	13.9	54	0.78	4.0	11.0
Lake Fork	18	NBR	LO	1990	1634	10.2	1.3	39	0	0.000	0.975	0.05	10.2	234	229	246	8.3			0.59	1.9			0.8	7.8
Station	19	NBR	LO	1990	1636	19.2	4.5	293	0	0.029	27.377	0.14	10.2	281	248	294	8.0			0.99	1.3			1.0	11.0
Little Jack	15	SRP	LO	1990	1072	31.1	3.3	99	65	0.001	1.212	0.05	18.8	125	57	50	7.9			0.89	8.4	34	1.01	0.8	56.3
Big Jack	16	SRP	LO	1990	1333	22.9	4.4	110	50	0.002	6.376	0.15	18.0	125	67	60	8.9			0.61	18.2	23	1.45	1.0	30.8
Cottonwood	17	SRP	LO	1990	1455	21.0	2.7	40	99	0.001	2.075	0.04	16.0	210	41	44	7.9			1.94	17.2	33	1.31	0.8	34.3
Big Willow	44	SRP	LO	1991	933	39.5	7.4	352	90	0.011	3.630	0.22	17.6	174	84	67	8.7	0.11	0.18	0.76	17.9	21	1.51	1.5	8.7
Cold Springs	45	SRP	LO	1991	1293	12.3	3.0	90	50	0.058	0.150	0.15	10.2	55	27	23	7.8	0.09	0.25	0.81	6.8	5	3.67	4.0	24.3
Current	46	SRP	LO	1991	1767	17.6	3.1	166	25	0.102	0.350	0.09	17.2	28	11	13	7.5	0.12	0.44	1.82	16.1	19	1.35	3.5	1.9
Duncan	47	SRP	LO	1991	1620	16.6	1.7	52	90	0.011	2.950	0.01	10.3	106	50	43	8.0	0.10	0.28	0.50	11.9	19	1.56	1.5	28.6
Spring	48	SRP	LO	1991	1147	17.3	2.0	85	70	0.245	2.660	0.01	14.3	121	57	72	7.9	0.09	0.35	0.71	7.5	36	0.84	3.0	31.2
Cassia	28	NBR	IM	1990	1500	23.2	6.7	402	7	0.002	4.163	0.45	13.5	115	81	106	8.3			0.94	5.2			0.5	21.3
Trapper	31	NBR	IM	1990	1539	26.4	6.6	198	25	0.010	7.202	0.34	14.5	151	119	161	8.5			1.25	8.3			1.0	14.9
SF Mink	49	NBR	IM	1991	1933	19.8	2.6	30	0	0.010	5.560	0.13	17.5	417	216	218	8.6	0.00	0.44	1.07	5.7	42	0.73	0.5	10.4
Wolverine	50	NBR	IM	1991	1833	10.3	2.1	120	10	0.011	0.830	0.19	14.6	497	211	230	8.8	0.13	0.06	1.11	9.7	50	0.59	1.5	9.8
Sheep	26	SRP	IM	1990	1467	20.2	6.6	198	3	0.004	2.835	0.59	14.7	72	57	68	7.9			0.81	10.6			2.0	19.6
Big Jack	27	SRP	IM	1990	1242	22.6	5.8	319	5	0.002	8.445	0.16	18.0	153	66	57	6.4			1.46	17.5	30	1.16	1.0	12.0
Mary's	29	SRP	IM	1990	1730	23.5	4.9	245	2	0.002	3.048	0.06	15.7	75	54	78	7.3			0.79	16.9	27	1.00	1.0	60.1
Shoshone	32	SRP	IM	1990	1636	21.8	8.3	208	0	0.000	0.468	0.69	16.0	92	63	82	7.1			0.82	8.7			1.0	25.2
Camas	51	SRP	IM	1991	1640	31.8	9.1	683	0	0.008	0.260	0.64	25.4	108	66	45	8.6	0.11	0.46	0.00	0.1	100	0.00	0.5	0.9
Deep	52	SRP	IM	1991	1727	21.5	5.7	597	0	0.007	1.830	0.13	18.6	51	24	19	7.6	0.06	0.23	1.52	3.2	59	0.77	1.0	8.2
Rock (Magic)	53	SRP	IM	1991	1716	13.7	2.4	202	5	0.200	0.360	0.10	17.6	286	126	131	8.3	0.22	0.16	0.83	7.3	27	1.62	4.0	18.8
Rock (Twin)	54	SRP	IM	1991	1219	33.0	5.9	750				7.56	16.8	570				1.19	0.15			75		1.0	

SUMMARY		(n)	ELEV	WIDTH/ DEPTH RATIO	MEAN WIDTH (m)	AREA SHOCKED (m-2)	% COVER	AFDM (g/cm2)	CHL-a (ug/cm	Q (m3/s)	TEMP (C)	SPEC. COND. (umhos)	ALK (mg/L) (CaCO3)	TOTAL HARD	pH	NO3	PO4	SUBSTRATE CV	SUBSTRATE AVG	EMBEDDEDNESS AVG	EMBEDDEDNESS CV	SLOPE	BOM AFDM
upland	mean	15	1914	19.58	3.26	149.8	54.1	0.01	0.74	0.15	11.8	143.9	71.0	82.1	8.2	0.07	0.06	0.90	15.7	33.6	1.01	5.4	22.7
	std		357	6.37	1.21	74.5	22.7	0.04	0.91	0.10	3.3	119.9	60.9	62.9	0.4	0.07	0.04	0.25	6.8	13.3	0.25	3.9	19.4
lowland	mean	10	1389	20.77	3.34	132.6	54.0	0.05	4.78	0.09	14.3	145.9	87.1	91.2	8.1	0.10	0.30	0.96	10.7	23.5	1.59	1.8	23.5
	std		265	8.29	1.67	102.2	34.3	0.07	7.73	0.07	3.5	74.9	78.2	91.7	0.4	0.01	0.09	0.48	6.1	9.7	0.82	1.2	15.6
impacted	mean	12	1599	22.34	5.56	329.3	5.2	0.02	3.18	0.92	16.9	183.4	98.5	108.7	7.9	0.10	0.25	0.96	8.5	51.2	0.84	1.3	18.4
	std		208	6.15	2.14	220.8	7.0	0.06	2.73	2.01	3.1	143.3	60.9	65.9	0.7	0.07	0.15	0.39	5.0	24.3	0.47	0.9	14.7
up-nbr	mean	8	1685	21.31	3.66	160.3	44.5	0.02	0.47	0.18	12.6	179.5	95.4	113.5	8.1	0.11	0.09	0.94	15.4	38.3	0.83	5.6	31.9
	std		128	7.57	1.32	79.3	24.2	0.05	0.53	0.11	3.5	150.9	69.4	64.5	0.5	0.10	0.03	0.25	8.4	10.9	0.13	3.6	22.1
up-srp	mean	7	2190	17.60	2.81	137.9	65.0	0.00	1.05	0.11	10.8	103.3	43.0	46.3	8.2	0.05	0.05	0.86	16.2	29.6	1.17	5.4	12.3
	std		347	3.74	0.87	66.6	14.6	0.00	1.13	0.07	2.8	41.0	31.3	36.2	0.2	0.02	0.04	0.23	4.2	13.9	0.23	4.2	6.5
lo-nbr	mean	2	1635	14.70	2.90	166.0	0.0	0.01	14.18	0.10	10.2	257.5	238.5	270.0	8.2			0.79	1.6			0.9	9.4
	std		1	4.50	1.60	127.0	0.0	0.01	13.20	0.05	0.0	23.5	9.5	24.0	0.2			0.20	0.3			0.1	1.6
lo-srp	mean	8	1328	22.29	3.46	124.3	67.5	0.05	2.43	0.09	15.3	118.0	49.2	46.5	8.1	0.10	0.30	1.01	13.0	23.5	1.59	2.0	27.0
	std		262	8.33	1.67	93.2	23.7	0.08	1.89	0.07	3.2	54.6	21.3	19.3	0.4	0.01	0.09	0.52	4.6	9.7	0.82	1.2	15.5
imp-nbr	mean	4	1701	19.93	4.51	187.5	10.5	0.01	4.44	0.28	15.0	295.0	156.9	178.6	8.6	0.07	0.25	1.09	7.2	46.2	0.66	0.9	14.1
	std		186	6.03	2.15	137.4	9.1	0.00	2.34	0.13	1.5	164.9	58.4	49.3	0.2	0.07	0.19	0.11	1.8	4.0	0.07	0.4	4.6
imp-srp	mean	8	1547	23.55	6.08	400.3	2.1	0.03	2.46	1.24	18.9	119.6	65.1	68.7	7.6	0.13	0.25	0.89	9.2	52.9	0.91	1.4	20.8
	std		199	5.84	1.93	220.5	2.1	0.07	2.67	2.40	3.3	74.3	28.5	32.3	0.7	0.07	0.13	0.47	6.0	27.7	0.53	1.0	17.6

laboratory for chlorophyll a and AFDM. Initially, samples were ground in reagent-grade acetone using a Brinkmann tissue homogenizer (Model PT 10/35). Chlorophyll a was extracted in reagent-grade acetone and quantified using a Gilford Model 2600 spectrophotometer (APHA 1989). The AFDM of each sample was determined as described above for BOM using the material from chlorophyll a analysis.

Multiple Discriminant Analysis (MDA) was completed using habitat measures (Table 3) including the qualitative habitat assessment categories (Table 4) in order to distinguish among stream types and between ecoregions. Analyses were completed on an HP-vectra (model RS/20) PC using the Statistica software program (Statsoft: Statistica 1990). Principal Components Analysis (PCA) also was used to determine important habitat measures for separating sites. Both analyses were found effective in determining important habitat measures and indicated the need to incorporate both qualitative and quantitative measures to describe stream habitat conditions. Selected quantitative measures were scored by proportional scaling of measured values over an arbitrary range of 0 to 15 (maximum score per measure equaled 15) to make them comparable with the habitat assessment categories. Individual scores were summed across measures for each site for an overall habitat score (e.g., see Table 5).

Field Sampling of Benthic Macroinvertebrates and Fish

In 1990, qualitative sampling was completed at all selected sites and additional quantitative samples collected at five of these sites (Robinson and Minshall 1991). In 1991, quantitative sampling was completed on all selected sites and additional qualitative samples collected at ten of these sites. Generally, field sampling for macroinvertebrates and fish was completed in ca. 10 person-hours (e.g., 5 crew members for 2 h) per site, and

Table 4. Summary of habitat assessment category scores for each study stream. Data for Rock Creek (Twin) sites from Idaho DEQ.

STATION	#	LOC	TYPE	SUBSTRATE COVER	EMBED	FLOW VELOCITY	CANOPY COVER	CHANNEL ALTER	BOTTOM SCOUR	POOL RIFFLE	WIDTH DEPTH	BANK STABILITY	BANK VEG	STREAM COVER	RIPARIAN WIDTH	TOTAL SCORE
Green	1	NBR	UP	20	20	18	20	15	15	13	12	10	10	9	10	172
Stinson	2	NBR	UP	20	20	18	20	15	15	13	12	10	10	9	10	172
Cottonwood	5	NBR	UP	18	18	18	16	15	15	14	12	10	10	10	8	164
Trapper	3	NBR	UP	19	20	19	11	15	11	13	11	10	10	8	8	155
Bloomington	35	NBR	UP	20	20	15	20	14	14	12	14	10	7	8	8	162
Mink	36	NBR	UP	20	20	18	17	13	14	14	14	10	9	8	8	165
WF Mink	37	NBR	UP	15	15	10	18	10	11	12	14	8	10	10	9	142
3rd Fork	8	NBR	UP	18	18	18	19	15	14	14	15	8	9	9	6	163
Timber	38	SRP	UP	19	15	13	20	13	10	13	14	9	9	8	8	151
SF Soldier	39	SRP	UP	13	16	13	20	14	11	12	15	10	10	9	10	153
Buck	4	SRP	UP	20	18	20	20	15	14	14	15	10	10	8	7	171
Cherry	40	SRP	UP	19	20	14	19	14	14	11	15	10	10	9	6	161
Bear	41	SRP	UP	16	18	19	17	12	12	14	14	10	9	6	7	154
Ramey	42	SRP	UP	20	20	13	18	15	13	13	15	10	9	8	8	162
Coyote	43	SRP	UP	18	18	15	19	12	12	15	15	10	10	9	8	161
Lake Fork	18	NBR	LO	15	18	10	0	15	14	11	3	9	10	5	6	116
Station	19	NBR	LO	15	18	10	0	11	9	10	12	5	8	6	7	111
Little Jack	15	SRP	LO	18	20	16	20	15	15	15	14	10	10	10	10	173
Big Jack	16	SRP	LO	20	14	18	18	15	11	15	14	10	10	10	9	164
Cottonwood	17	SRP	LO	18	10	14	10	15	15	10	14	10	10	10	8	144
Big Willow	44	SRP	LO	20	14	13	20	11	9	12	11	10	10	9	8	147
Cold Springs	45	SRP	LO	17	19	12	19	14	12	13	14	9	10	9	10	158
Current	46	SRP	LO	18	18	20	17	14	13	15	15	10	10	10	8	168
Duncan	47	SRP	LO	18	18	13	16	15	12	8	9	10	10	10	9	148
Spring	48	SRP	LO	13	9	7	19	15	11	8	10	10	10	10	8	130
Cassia	28	NBR	IM	15	11	17	5	6	6	13	3	7	9	8	6	106
Trapper	31	NBR	IM	13	1	18	15	1	9	8	11	3	9	4	7	99
SF Mink	49	NBR	IM	16	17	12	13	6	3	8	10	1	8	7	7	108
Wolverine	50	NBR	IM	6	12	6	5	4	3	5	5	1	5	3	1	56
Sheep	26	SRP	IM	17	17	19	2	7	9	12	3	1	8	9	1	105
Big Jack	27	SRP	IM	10	11	15	3	11	11	13	14	7	10	5	1	111
Mary's	29	SRP	IM	13	11	17	5	6	6	13	6	1	8	7	6	99
Shoshone	32	SRP	IM	8	3	8	0	10	10	6	3	4	10	4	3	69
Camas	51	SRP	IM	0	6	1	0	1	1	4	2	3	3	3	3	27
Deep	52	SRP	IM	5	11	7	3	6	8	7	4	2	3	4	8	66
Rock (Magic)	53	SRP	IM	9	10	6	6	11	9	11	12	5	4	3	4	90
Rock (Twin)	54	SRP	IM													107

SUMMARY		(n)	SUBSTRATE COVER	EMBED	FLOW VELOCITY	CANOPY COVER	CHANNEL ALTER	BOTTOM SCOUR	POOL RIFFLE	WIDTH DEPTH	BANK STABILITY	BANK VEG	STREAM COVER	RIPARIAN WIDTH	TOTAL SCORE
upland	mean	15	18.3	18.4	16.1	18.3	13.8	13.0	13.1	13.8	9.7	9.5	8.5	8.1	160.5
	std		2.1	1.8	2.9	2.3	1.5	1.6	1.0	1.3	0.7	0.8	1.0	1.2	8.1
lowland	mean	10	17.2	15.8	13.3	13.9	14.0	12.1	11.7	11.6	9.3	9.8	8.9	8.3	145.9
	std		2.1	3.7	3.7	7.5	1.5	2.1	2.6	3.4	1.5	0.6	1.8	1.2	20.2
impacted	mean	12	10.2	10.0	11.5	5.2	6.3	6.6	9.1	6.6	3.2	7.0	5.2	4.3	86.9
	std		5.0	4.8	5.8	4.6	3.3	3.1	3.3	4.1	2.2	2.6	2.1	2.5	25.4
up-nbr	mean	8	18.8	18.9	16.8	17.6	14.0	13.6	13.1	13.0	9.5	9.4	8.9	8.4	161.9
	std		1.6	1.7	2.8	2.9	1.7	1.6	0.8	1.3	0.9	1.0	0.8	1.2	9.1
up-srp	mean	7	17.9	17.9	15.3	19.0	13.6	12.3	13.1	14.7	9.9	9.6	8.1	7.7	159.0
	std		2.4	1.7	2.8	1.1	1.2	1.4	1.2	0.5	0.3	0.5	1.0	1.2	6.4
lo-nbr	mean	2	15.0	18.0	10.0	0.0	13.0	11.5	10.5	7.5	7.0	9.0	5.5	6.5	113.5
	std		0.0	0.0	0.0	0.0	2.0	2.5	0.5	4.5	2.0	1.0	0.5	0.5	2.5
lo-srp	mean	8	17.8	15.3	14.1	17.4	14.3	12.3	12.0	12.6	9.9	10.0	9.8	8.8	154.0
	std		2.0	3.9	3.7	3.1	1.3	1.9	2.8	2.1	0.3	0.0	0.4	0.8	13.4
imp-nbr	mean	4	12.5	10.3	13.3	9.5	4.3	5.3	8.5	7.3	3.0	7.8	5.5	5.3	92.3
	std		3.9	5.8	4.8	4.6	2.0	2.5	2.9	3.3	2.4	1.6	2.1	2.5	21.2
imp-srp	mean	8	8.9	9.9	10.4	2.7	7.4	7.4	9.4	6.3	3.3	6.6	5.0	3.7	84.3
	std		5.1	4.1	6.1	2.1	3.3	3.2	3.4	4.4	2.1	2.9	2.1	2.4	26.8

Table 5. Modified habitat score based on factors shown important by statistical analyses. Score combines quantitative and qualitative categories.

STATION	#	LOC	WIDTH/ DEPTH RATIO	SCR	% COVER	SCR	CHL-a	SCR	TEMP (C)	SCR	SPEC. COND.	SCR	NO3	SCR	PO4	SCR	SUBST AVG	SCR	EMBED AVG	SCR	SLOPE	SCR	FLOW	CAN COVER	POOL RIF	BANK STAB	STREAM COVER	RIP WIDTH	TOTAL SCORE	*PRE-MODIFIED SCORE
Green	1	SRP	15.9	15	65	15	0.221	15	10.0	15	22	15					28.4	15			12.0	15	18	20	13	10	9	10	217	172
Stinson	2	SRP	13.1	15	80	15	0.329	15	13.6	7	27	15					6.4	3			9.0	15	18	20	13	10	9	10	194	172
Buck	4	SRP	14.3	15	50	11	3.520	2	15.2	4	137	12					10.5	7			9.0	15	20	20	14	10	8	7	171	171
Cottonwood	5	SRP	21.8	5	30	8	0.176	15	14.3	5	59	15					15.7	12			1.0	6	18	16	14	10	10	8	167	164
3rd Fork	8	NBR	29.4	2	50	11	0.009	15	9.0	15	78	14					20.8	15	31.0	8	2.0	9	18	19	14	8	9	6	163	163
Trapper	3	NBR	18.5	14	1	0	1.022	9	16.7	2	151	11					5.5	2	27.2	9	2.0	9	19	11	13	10	8	8	125	155
Bloomington	35	NBR	17.4	14	50	11	0.130	15	6.3	15	391	1	0.08	10	0.07	14	22.3	15	38.8	7	7.0	15	15	20	12	10	8	8	190	162
Mink	36	NBR	37.3	1	20	5	0.190	15	15.0	4	317	1	0.24	1	0.06	14	19.5	15	36.2	7	6.0	15	18	17	14	10	8	8	153	165
WF Mink	37	NBR	17.1	14	60	14	1.650	8	16.2	3	391	1	0.01	15	0.13	9	4.4	2	58.5	1	4.5	14	10	18	12	8	10	9	148	142
Timber	38	SRP	18.9	14	60	14	0.379	15	9.5	15	160	10	0.03	15	0.11	11	16.9	13	25.8	10	3.0	11	13	20	13	9	8	8	199	151
SF Soldier	39	SRP	22.9	4	75	15	0.200	15	7.2	15	39	15	0.07	11	0.09	13	19.6	15	21.8	14	4.0	13	13	20	12	10	9	10	204	153
Cherry	40	SRP	18.9	14	45	10	0.373	15	14.0	6	142	11	0.03	15	0.01	15	14.2	10	21.0	14	3.5	12	14	19	11	10	9	6	191	161
Bear	41	SRP	17.9	14	90	15	0.781	10	10.5	15	82	14	0.03	15	0.04	15	13.9	10	41.5	6	0.5	5	19	17	14	10	6	7	189	154
Ramey	42	SRP	10.5	15	60	14	1.789	7	7.5	15	95	13	0.07	11	0.06	14	24.1	15	13.2	15	14.0	15	13	18	13	10	8	8	204	162
Coyote	43	SRP	19.8	10	75	15	0.284	15	12.0	11	68	15	0.04	15	0.01	15	13.9	10	54.1	2	4.0	13	15	19	15	10	9	8	197	161
Little Jack	15	SRP	31.1	1	65	15	1.212	7	18.8	1	125	12					8.4	4	33.5	8	0.8	5	16	20	15	10	10	10	134	173
Big Jack	16	SRP	22.9	4	50	11	6.376	1	18.0	1	125	12					18.2	15	22.5	14	1.0	6	18	18	15	10	10	9	144	164
Cottonwood	17	SRP	21.0	7	99	15	2.075	4	16.0	3	210	1					17.2	14	33.2	8	0.8	5	14	10	10	10	10	8	119	144
Lake Fork	18	NBR	10.2	15	0	0	0.975	8	10.2	15	234	1					1.9	1			0.8	5	10	0	11	9	5	6	102	116
Station	19	NBR	19.2	12	0	0	27.377	0	10.2	15	281	1					1.3	1			1.0	6	10	0	10	5	6	7	87	111
Big Willow	44	SRP	39.5	1	90	15	3.630	2	17.6	1	174	9	0.11	4	0.18	7	17.9	14	21.2	14	1.5	8	13	20	12	10	9	8	147	147
Cold Springs	45	SRP	12.3	15	50	11	0.150	15	10.2	15	55	15	0.09	7	0.25	3	6.8	3	4.6	15	4.0	13	12	19	13	9	9	10	184	158
Current	46	SRP	17.6	14	25	5	0.350	15	17.2	1	28	15	0.12	3	0.44	1	16.1	13	18.8	15	3.5	12	20	17	15	10	10	8	174	168
Duncan	47	SRP	16.6	14	90	15	2.950	2	10.3	15	106	13	0.10	6	0.28	3	11.9	7	18.5	15	1.5	8	13	16	8	10	10	9	164	128
Spring	48	SRP	17.3	14	70	15	2.660	2	14.3	5	121	12	0.09	7	0.35	2	7.5	3	35.7	7	3.0	11	7	19	8	10	10	8	140	130
Big Jack	27	SRP	22.9	4	5	1	8.445	1	18.0	1	153	10					17.5	14	29.8	8	1.0	6	15	3	13	7	5	1	89	111
Cassia	28	NBR	23.2	4	7	1	4.163	1	13.5	8	115	12					5.2	2			0.5	2	17	5	13	7	8	6	102	106
Sheep	26	SRP	20.2	9	3	0	2.835	2	14.7	5	72	14					10.6	7			2.0	9	19	2	12	1	9	1	107	105
Mary's	29	SRP	23.5	4	2	0	3.048	2	15.7	4	75	14					16.9	13	26.9	9	1.0	6	17	5	13	1	7	6	101	99
Trapper	31	NBR	26.4	3	25	5	7.202	1	14.5	5	151	10					8.3	4			1.0	6	18	15	8	3	4	7	105	99
Shoshone	32	SRP	21.8	5	0	0	0.468	14	16.0	3	92	13					8.7	4			1.0	6	8	0	6	4	4	3	83	69
SF Mink	49	NBR	19.8	10	0	0	5.560	1	17.5	1	417	0	0.00	15	0.44	1	5.7	2	42.2	6	0.5	2	12	13	8	1	7	7	86	108
Wolverine	50	NBR	10.3	15	10	2	0.830	10	14.6	5	497	0	0.13	3	0.06	14	9.7	5	50.2	4	1.5	8	6	5	5	1	3	1	87	56
Camas	51	SRP	31.8	2	0	0	0.260	15	25.4	0	108	13	0.11	4	0.46	1	0.1	0	99.0	0	0.5	2	1	0	4	3	3	3	51	27
Deep	52	SRP	21.5	5	0	0	1.830	7	18.6	1	51	15	0.06	14	0.23	3	3.2	1	58.5	1	1.0	6	7	3	7	2	4	8	84	66
Rock (Magic)	53	SRP	13.7	15	5	0	0.360	15	17.6	1	286	1	0.22	1	0.16	8	7.3	3	27.0	9	4.0	13	6	6	11	5	3	4	101	90

		WIDTH/ DEPTH RATIO	% COVER	CHL-a	TEMP (C)	SPEC. COND.	NO3	PO4	SUBST AVG	EMBED AVG	SLOPE
UPLAND	mean	19.6	54.1	0.74	11.8	144	0.07	0.06	15.7	33.6	5.4
LOWLAND	mean	20.8	54.0	4.78	14.3	146	0.10	0.30	10.7	23.5	1.8
IMPACTED	mean	21.4	5.2	3.18	16.9	183	0.10	0.27	8.5	47.8	1.3
HABITAT SCORE											
optimal	11-15	<19.6	>50	<0.74	<12.0	<150	<0.07	<.10	>15.0	<25	>3.0
marginal	6-10	19.6-21.4	25-50	.75-2.0	12-14	150-200	.07-.10	.10-.20	10-15	25-50	1-3
poor	0-5	>21.4	<25	>2.0	>14	>200	>.10	>.20	<10.0	>50	<1

*premodified score based on categories from habitat assessment field data sheet (see table 2).

only two sites typically were completed in one day due to the remote locations of sites. Qualitative sampling followed protocols III and V of the Rapid Bioassessment Protocols recommended by the US Environmental Protection Agency (Plafkin et al. 1989). No separate "leaf pack" (coarse particulate organic matter/shredder) samples were collected due to the paucity of this material in the streams at the time of sampling (mid-summer). The rarity of leaf packs during a significant portion of the ice-free period indicates that this metric is of little value in these ecoregions, unless collected in mid to late autumn (the period of leaf fall).

Benthic macroinvertebrates were qualitatively collected from riffle/run habitats using a metal-framed net (1-mm mesh in 1990 and 500-μm mesh in 1991, 30cm high x 60cm wide x 100cm long) affixed to a "D"-style scoop shovel handle. A 3-minute sample was proportioned between riffle and run habitats along a 150m length of stream. The material in the net was stored in labeled Whirl-pac^{tm} bags and preserved with 10% formalin. The material was transferred into 70% ETOH in the laboratory for sample storage. Quantitative benthic samples were collected at five riffle/run habitats using a modified Hess net (250-μm mesh)(Waters and Knapp 1961). Quantitative sampling followed the methodology described in Platts et al. (1983).

In the laboratory, a 300-count sample of macroinvertebrates was systematically handpicked from each qualitative sample for metric analysis. In 1990, all macroinvertebrates were removed from each quantitative sample. In 1991, the five quantitative samples from a site were combined and a minimum of 300 organisms were systematically handpicked from the composited sample. To maintain the quantitative nature of the Hess sample, the composited sample was placed in a pan equally divided into twelve compartments or cells. All macroinvertebrates were removed from randomly selected cells until 300 or more organisms were removed.

For example, a cell was completely picked of organisms regardless of whether 300 organisms were removed before completing the cell. Values of handpicked specimens were then multiplied by the appropriate constant (12/no. of cells completed) for estimates of total abundance. These data also were used for estimates of macroinvertebrate densities. All picked macroinvertebrates from qualitative or quantitative samples were identified to lowest feasible taxonomic unit (usually species level) and enumerated. Specimens of all macroinvertebrate taxa collected were retained for voucher collections and housed at the Stream Ecology Center of Idaho State University; voucher specimens also were deposited with the Idaho Department of Health and Welfare, Bureau of Laboratories; and the Orma J. Smith Museum of Natural History, Albertson College of Idaho, Caldwell, Idaho.

Fish were collected using a gas-powered Cofelt Model BP-6 backpack electrofisher (110 or 220 AC voltage) downstream from the benthic macroinvertebrate sample section. All sites had at least one pass made with the electrofisher along a maximum 100-m reach of stream encompassing a minimum of two riffles/runs and two pools, or a minimum of 100 fish collected. Blocknets were installed below and above each section prior to electrofishing. Three passes were completed at 15 sites for a quantitative estimate of fish abundance (Zippin 3-step method; Platts et al. 1983). The fish from each pass were identified, counted, weighed, and noted for any external anomalies. A specimen of each species was retained for reference and for verification of field identifications, and all remaining captured fish released. The voucher specimens were deposited in the Orma J. Smith Museum of Natural History, Albertson College of Idaho, Caldwell, Idaho.

Data Analysis

Biotic metrics were calculated from the fish and macoinvertebrate data from each site as described in Winget and Magnum (1979), Platts et al. (1983), Plafkin et al. (1989), Fisher (1989), Clark and Maret (1991), and Chandler and Maret (1991). Eighteen metrics were calculated for benthic macroinvertebrates: ratio of Ephemeroptera, Plecoptera, and Trichoptera (EPT) abundance to Chironomidae (Ch) and Oligochaeta (O) abundance (EPT/Ch+O); species richness; EPT richness; Hilsenhoff Biotic Index (HBI); Biotic Condition Index (BCI); ratio of EPT/Ch; % dominance; Shannon's diversity index (H'); Simpson's dominance index (C); ratio of Scrapers/Filterers (S/F ratio); ratio of Shredders/Total; macroinvertebrate density; % Scrapers; % Filterers; % Shredders; % EPT taxa; % CH+O; and % Chironomidae (Table 6). The HBI used an assumed scale from 0-10 (Hilsenhoff 1988), and regional tolerance values from Wisseman (1990).

Twenty metrics were calculated for fish: Species richness; Number of native species; Number of introduced species; Number of Salmonidae species; Number of benthic insectivore species; Number of intolerant species; Number of tolerant species; % introduced species; % carnivores; % omnivores; % insectivores; % Salmonidae; total density; total biomass; Salmonidae density; Salmonidae biomass; Tolerant density; Tolerant biomass; % Young-of-Year; and Salmonidae condition factor (Table 7). Fish Condition Index was calculated as: (weight in grams)/(total length^3)*(10^5). Fish tolerance, trophic guild, and native/introduced designations were determined from Chandler and Maret (1991)(Table 8).

Values for criteria scores were determined using recommendations in Plafkin et al. (1989) and based on the 95% confidence limits about the mean absolute value for upland (reference) sites. For example, a score of 5 (representing the optimal value for a metric) was recorded if the absolute value for that metric was greater than (or less than, if a low value indicated the optimal condition) the 95% confidence limit about

Table 6. Absolute values and respective scores for macroinvertebrate metrics used for metric development.

TYPE	# REP #		NBR/SRP	EPT/ (CHIR+OLIG)	SCORE	SPECIES RICHNESS	SCORE	EPT RICHNESS	SCORE	HBI INDEX	SCORE	BCI INDEX	SCORE	EPT/CHIR	SCORE	% DOM	SCORE	H' DIVERSITY	SCORE	SIMPSON'S INDEX	SCORE
Up	1	QUAL.	1	7.3	3	31	5	17	5	3.28	5	92	1	7.6	3	0.20	5	2.71	5	0.10	5
Up	2	QUAL.	1	3.5	1	11	1	4	1	3.04	5	81	1	3.5	1	0.92	1	0.45	1	0.85	1
Up	3	QUAL.	1	23.3	5	21	1	8	1	4.18	1	86	1	31.0	5	0.56	1	1.67	1	0.36	1
Up	4	QUAL.	2	8.2	3	17	1	7	1	3.16	5	77	1	8.2	3	0.33	3	1.91	1	0.21	3
Up	5	QUAL.	1	1.3	1	22	1	12	1	4.41	1	90	1	1.3	1	0.36	3	2.21	1	0.18	5
Up	8	QUAL.	1	1.6	1	15	1	8	1	4.24	1	72	1	1.6	1	0.45	1	1.85	1	0.25	1
Up	37	QUAL.	1	3.4	1	17	1	11	1	3.01	5	127	5	4.1	1	0.16	5	2.66	5	0.09	5
Up	39	QUAL.	2	20.9	5	28	5	13	3	1.96	5	110	5	251.0	5	0.32	5	2.15	1	0.19	3
Up	40	QUAL.	2	4.7	1	25	3	15	5	2.75	5	110	5	12.6	5	0.14	5	2.73	5	0.08	5
Up	43	QUAL.	2	2.2	1	24	3	14	3	4.19	1	90	1	2.5	1	0.27	5	2.50	5	0.14	5
Up	35	QUAN.	1	10.4	5	29	5	9	1	4.14	1	80	1	12.5	5	0.26	5	2.08	1	0.17	5
Up	36	QUAN.	1	10.8	5	19	1	15	5	3.36	5	86	1	22.5	5	0.26	5	2.50	5	0.13	5
Up	37	QUAN.	1	3.5	1	25	3	17	5	3.74	3	123	5	4.5	1	0.28	5	2.57	5	0.13	5
Up	38	QUAN.	2	2.7	1	28	5	12	1	3.57	5	86	1	8.4	3	0.14	5	2.56	5	0.10	5
Up	39	QUAN.	2	0.3	1	22	1	13	3	4.46	1	86	1	12.0	5	0.71	1	1.34	1	0.51	1
Up	40	QUAN.	2	1.2	1	21	1	16	5	3.94	1	97	3	1.8	1	0.27	5	2.36	3	0.14	5
Up	41	QUAN.	2	1.1	1	24	3	17	5	3.19	5	115	5	2.8	1	0.25	5	2.52	5	0.12	5
Up	42	QUAN.	2	0.8	1	24	3	18	5	3.60	5	123	5	0.0	1	0.49	1	2.06	1	0.27	1
Up	43	QUAN.	2	1.2	1	27	5	16	5	4.07	1	86	1	1.6	1	0.32	5	2.43	5	0.15	5
Lo	15	QUAL.	2	1.2	1	20	1	7	1	4.13	1	77	1	1.3	1	0.22	5	2.45	5	0.11	5
Lo	16	QUAL.	2	0.3	1	30	5	7	1	4.68	1	67	1	0.4	1	0.39	1	2.24	1	0.21	3
Lo	17	QUAL.	2	1.9	1	24	3	10	1	4.14	1	70	1	1.7	1	0.29	5	2.23	1	0.16	5
Lo	18	QUAL.	1	1.7	1	19	1	3	1	4.49	1	80	1	1.9	1	0.18	5	2.37	3	0.12	5
Lo	19	QUAL.	1	3.6	1	18	1	5	1	4.93	1	81	1	21.7	5	0.29	5	2.35	3	0.13	5
Lo	48	QUAL.	2	0.9	1	17	1	6	1	4.42	1	94	1	0.9	1	0.36	3	1.94	1	0.21	3
Lo	44	QUAN.	2	1.4	1	21	1	9	1	4.17	1	71	1	1.7	1	0.43	1	1.99	1	0.23	1
Lo	45	QUAN.	2	1.0	1	22	1	11	1	3.79	3	125	5	1.5	1	0.21	5	2.48	5	0.12	5
Lo	46	QUAN.	2	1.5	1	23	3	11	1	3.95	1	77	1	1.5	1	0.22	5	2.33	3	0.13	5
Lo	47	QUAN.	2	0.0	1	8	1	1	1	5.45	1	56	1	0.0	1	0.69	1	1.05	1	0.51	1
Lo	48	QUAN.	2	0.6	1	19	1	8	1	4.67	1	90	1	0.7	1	0.40	1	2.18	1	0.19	3
Im	26	QUAL.	2	0.5	1	16	1	5	1	5.49	1	52	1	0.5	1	0.48	1	1.62	1	0.31	1
Im	27	QUAL.	2	2.4	1	21	1	9	1	3.81	3	72	1	2.6	1	0.21	5	2.44	3	0.12	5
Im	28	QUAL.	1	0.8	1	18	1	5	1	4.29	1	80	1	1.0	1	0.32	5	2.11	1	0.18	5
Im	29	QUAL.	2	0.6	1	24	3	5	1	5.20	1	62	1	0.8	1	0.38	3	2.22	1	0.19	3
Im	31	QUAL.	1	9.8	5	18	1	5	1	3.26	5	70	1	11.9	5	0.28	5	2.09	1	0.17	5
Im	32	QUAL.	2	3.0	1	23	3	7	1	4.61	1	64	1	4.0	1	0.12	5	2.73	5	0.08	5
Im	49	QUAL.	1	6.1	3	15	1	5	1	4.82	1	82	1	9.8	3	0.63	1	1.49	1	0.42	1
Im	50	QUAL.	1	2.0	1	18	1	6	1	4.95	1	70	1	2.3	1	0.43	1	1.84	1	0.25	1
Im	51	QUAL.	2	4.4	1	13	1	4	1	3.25	5	71	1	19.1	5	0.45	1	1.49	1	0.31	1
Im	52	QUAL.	2	3.0	5	19	1	4	1	4.49	1	76	1	10.9	3	0.47	1	1.42	1	0.43	1
Im	53	QUAL.	2	17.2	5	11	1	3	1	4.93	1	140	5	0.0	1	0.64	1	1.44	1	0.30	1
Im	49	QUAN.	1	0.3	1	11	1	3	1	5.20	1	68	1	0.8	1	0.45	1	1.48	1	0.28	1
Im	50	QUAN.	1	34.4	5	19	1	9	1	4.43	1	71	1	39.3	5	0.40	1	1.36	1	0.48	1
Im	51	QUAN.	2	1.1	1	10	1	4	1	4.27	1	67	1	3.1	1	0.69	1	1.68	1	0.22	3
Im	52	QUAN.	2	2.7	1	20	1	10	1	4.77	1	88	1	3.0	1	0.30	5	1.66	1	0.32	1
Im	53	QUAN.	2	14.1	5	14	1	5	1	4.87	1	103	3	0.0	1	0.52	1	1.52	1	0.30	1
Im	54	QUAN.	2	1.2	1	15	1	3	1	7.69	1	57	1	1.2	1	0.90	1	0.54	1	0.81	1
	SCORE 5			>8.8		>25.4		>14.6		<3.59		>103.6		>11.49		<0.32		>2.45		<0.18	
	3			5.7-8.8		23.1-25.4		12.7-14.6		3.59-3.90		95.7-103.6		7.69-11.49		0.32-0.38		2.26-2.45		0.18-0.22	
	1			<5.7		<23.1		<12.6		>3.90		<95.7		<7.69		>0.38		<2.26		>0.22	
UPLAND N=19	MEAN			5.70		23.11		12.74		3.59		95.67		7.69		0.32		2.26		0.18	
	STDERR			1.47		1.08		0.89		0.15		3.79		1.81		0.03		0.09		0.02	
	95% CL			3.08		2.26		1.87		0.31		7.93		3.80		0.06		0.19		0.04	
	MEAN+CL			8.79		25.36		14.60		3.90		103.60		11.49		0.38		2.45		0.22	

Table 6. (cont.)

TYPE	#	REP	# NBR/SRP	S/F RATIO	SCORE	% SCRAPERS	SCORE	% FILTERERS	SCORE	% SHREDDERS	SCORE	% EPT	SCORE	% (CHIR+OLIG)	SCORE	% CHIR	SCORE	TOTAL SCORE MAX=80
Up	1	QUAL.	1	3.15	1	0.57	5	0.16	1	0.03	1	0.65	5	0.09	5	0.08	5	60
Up	2	QUAL.	1	0.04	1	0.04	1	0.92	1	0.00	1	0.05	1	0.01	5	0.01	5	28
Up	3	QUAL.	1	3.80	1	0.26	1	0.07	3	0.03	1	0.31	1	0.01	5	0.01	5	34
Up	4	QUAL.	2	9.40	1	0.46	5	0.07	3	0.01	1	0.53	3	0.06	5	0.06	5	42
Up	5	QUAL.	1	2.69	1	0.30	1	0.11	1	0.06	3	0.46	1	0.36	1	0.36	1	24
Up	8	QUAL.	1	0.44	1	0.08	1	0.18	1	0.05	3	0.28	1	0.18	5	0.17	3	24
Up	37	QUAL.	1	38.50	5	0.32	1	0.01	5	0.22	5	0.67	5	0.20	3	0.16	3	60
Up	39	QUAL.	2	22.75	3	0.67	5	0.03	5	0.00	1	0.92	5	0.04	5	0.00	5	66
Up	40	QUAL.	2	6.10	1	0.48	5	0.08	3	0.09	5	0.76	5	0.16	5	0.06	5	68
Up	43	QUAL.	2	5.50	1	0.38	3	0.07	3	0.05	3	0.58	3	0.27	3	0.23	1	44
Up	35	QUAN.	1	87.00	5	0.55	5	0.01	5	0.02	1	0.59	3	0.06	5	0.05	5	54
Up	36	QUAN.	1	13.53	1	0.62	5	0.05	5	0.02	1	0.75	5	0.07	5	0.03	5	68
Up	37	QUAN.	1	6.67	1	0.25	1	0.04	5	0.08	5	0.41	1	0.12	5	0.09	5	58
Up	38	QUAN.	2	0.00	1	0.24	1	0.00	5	0.15	5	0.53	3	0.20	3	0.06	5	50
Up	39	QUAN.	2	44.00	5	0.16	1	0.00	5	0.00	1	0.22	1	0.73	1	0.02	5	34
Up	40	QUAN.	2	13.50	1	0.26	1	0.02	5	0.05	3	0.50	1	0.43	1	0.27	1	40
Up	41	QUAN.	2	2.21	1	0.21	1	0.09	1	0.07	3	0.49	1	0.43	1	0.17	3	46
Up	42	QUAN.	2	21.33	3	0.25	1	0.01	5	0.04	1	0.40	1	0.49	1	0.00	5	40
Up	43	QUAN.	2	8.88	1	0.24	1	0.03	5	0.03	1	0.49	1	0.40	1	0.32	1	40
Lo	15	QUAL.	2	1.53	1	0.10	1	0.06	5	0.19	5	0.29	1	0.25	3	0.22	1	38
Lo	16	QUAL.	2	1.25	1	0.05	1	0.04	5	0.02	1	0.14	1	0.42	1	0.39	1	26
Lo	17	QUAL.	2	11.88	1	0.30	1	0.02	5	0.13	5	0.50	1	0.32	1	0.29	1	34
Lo	18	QUAL.	1	0.67	1	0.16	1	0.24	1	0.00	1	0.31	1	0.18	5	0.16	3	32
Lo	19	QUAL.	1	1.47	1	0.37	3	0.25	1	0.09	5	0.42	1	0.12	5	0.02	5	44
Lo	48	QUAL.	2	3.33	1	0.03	1	0.01	5	0.16	5	0.32	1	0.36	1	0.36	1	28
Lo	44	QUAN.	2	3.08	1	0.11	1	0.04	5	0.01	1	0.25	1	0.18	5	0.15	3	26
Lo	45	QUAN.	2	3.29	1	0.18	1	0.05	5	0.02	1	0.33	1	0.34	1	0.21	1	38
Lo	46	QUAN.	2	4.00	1	0.21	1	0.05	5	0.01	1	0.33	1	0.22	3	0.22	1	34
Lo	47	QUAN.	2	0.00	1	0.00	1	0.00	5	0.01	1	0.03	1	0.78	1	0.69	1	20
Lo	48	QUAN.	2	1.80	1	0.05	1	0.03	5	0.05	3	0.28	1	0.51	1	0.40	1	24
Im	26	QUAL.	2	0.17	1	0.08	1	0.48	1	0.00	1	0.15	1	0.29	1	0.28	1	16
Im	27	QUAL.	2	0.75	1	0.15	1	0.21	1	0.00	1	0.53	3	0.23	3	0.20	1	32
Im	28	QUAL.	1	1.17	1	0.13	1	0.12	1	0.00	1	0.31	1	0.37	1	0.32	1	24
Im	29	QUAL.	2	0.93	1	0.13	1	0.14	1	0.00	1	0.31	1	0.48	1	0.38	1	22
Im	31	QUAL.	1	1.16	1	0.29	1	0.25	1	0.06	3	0.60	3	0.06	5	0.05	5	48
Im	32	QUAL.	2	0.46	1	0.13	1	0.29	1	0.06	3	0.45	1	0.15	5	0.11	5	40
Im	49	QUAL.	1	29.43	5	0.68	5	0.02	5	0.01	1	0.75	5	0.12	5	0.08	5	44
Im	50	QUAL.	1	3.93	1	0.45	5	0.11	1	0.01	1	0.56	3	0.28	1	0.25	1	22
Im	51	QUAL.	2	0.14	1	0.01	1	0.05	5	0.00	1	0.76	5	0.17	5	0.04	5	40
Im	52	QUAL.	2	76.33	5	0.70	5	0.01	5	0.00	1	0.74	5	0.07	5	0.07	5	46
Im	53	QUAL.	2	0.50	1	0.24	1	0.48	1	0.06	3	0.33	1	0.02	5	0.00	5	34
Im	49	QUAN.	1	25.75	5	0.24	1	0.01	5	0.00	1	0.24	1	0.69	1	0.29	1	24
Im	50	QUAN.	1	5.09	1	0.69	5	0.13	1	0.01	1	0.86	5	0.03	5	0.02	5	40
Im	51	QUAN.	2	0.05	1	0.01	1	0.11	1	0.00	1	0.46	1	0.43	1	0.15	3	24
Im	52	QUAN.	2	34.00	5	0.59	5	0.02	5	0.00	1	0.64	5	0.23	3	0.21	1	34
Im	53	QUAN.	2	1.48	1	0.45	5	0.31	1	0.08	5	0.55	1	0.04	5	0.00	5	38
Im	54	QUAN.	2	0.49	1	0.02	1	0.04	5	0.00	1	0.03	1	0.03	5	0.03	5	28
	SCORE																	
	5			>25.1		>0.43		<0.06		>0.08		>0.61		<0.19		<0.12		
	3			15.1-25.1		0.35-0.43		0.06-0.08		0.05-0.08		0.53-0.61		0.19-0.27		0.12-0.17		
	1			<15.1		<0.35		>0.08		<0.05		<0.53		>0.27		>0.17		
UPLAND N=19	MEAN			15.08		0.35		0.06		0.05		0.53		0.19		0.12		
	STDERR			4.79		0.04		0.01		0.01		0.04		0.04		0.03		
	95% CL			10.02		0.08		0.02		0.02		0.08		0.08		0.05		
	MEAN+CL			25.10		0.43		0.08		0.08		0.61		0.27		0.17		

Table 7. Summary of fish metrics derived from electrofishing collections in the Snake River Plain and Northern Basin and Range Ecoregions.

STREAM	TYPE	SPECIES RICH	NUMBER NATIVE SPECIES	NUM INTRO(a) SPECIES	NUM SALMON SPECIES	NUM BENTHIC INSECT.	NUM INTOL(b) SPECIES	NUM TOL(c) SPECIES	% INTRO SPECIES	% CARNI	% OMNIV	% INSECT	% SALMON	DENS (#/m2)	BIOM (g/m2)	SALMON DENS	SALMON BIOM	TOLER DENS	TOLER BIOM	% YOY	COND FACTOR
Green	Up	2	1	1	2	2	2	0	50	100	0	100	100	0.04	1.9	0.039	1.93	0.00	0.00	0	1.08
Stinson	Up	1	0	1	1	1	1	0	100	100	0	100	100	0.12	8.5	0.121	8.54	0.00	0.00	0	1.07
Trapper (upper)	Up	2	2	0	1	2	2	0	0	50	0	100	50	0.10	1.1	0.092	1.07	0.00	0.00	25	1
Buck	Up	1	1	0	1	1	1	0	0	100	0	100	100	0.08	1.7	0.079	1.67	0.00	0.00	0	0.88
Cottonwood	Up	4	3	1	3	4	4	0	25	75	0	100	75	0.23	2.8	0.165	2.66	0.00	0.00	54	0.97
3rd Fork	Up	1	1	0	1	1	1	0	0	100	0	100	100	0.22	7.0	0.222	7.02	0.00	0.00	10	0.97
Bloomington	Up	1	1	0	1	1	1	0	0	100	0	100	100	0.01	0.2	0.005	0.18	0.00	0.00	0	1.36
Mink (Preston)	Up	1	0	1	1	1	1	0	100	100	0	100	100	0.23	5.7	0.225	5.69	0.00	0.00	0	1.16
WF Mink (Poc.)	Up	1	1	0	1	1	1	0	0	100	0	100	100	0.10	2.0	0.100	1.95	0.00	0.00	0	1.06
Timber	Up	1	0	1	1	1	1	0	100	100	0	100	100	0.08	3.9	0.082	3.85	0.00	0.00	10	1.13
SF Soldier	Up	2	1	1	1	2	2	0	50	50	0	100	50	0.04	0.6	0.018	0.40	0.00	0.00	60	1.32
Cherry	Up	1	1	0	0	1	1	0	0	0	0	100	0	0.13	0.6	0.000	0.00	0.00	0.00	0	NA
Bear	Up	1	0	1	1	1	1	0	100	100	0	100	100	0.02	0.8	0.022	0.82	0.00	0.00	20	1.07
Ramey	Up	1	0	1	1	1	1	0	100	100	0	100	100	0.02	1.5	0.018	1.51	0.00	0.00	0	1.29
Coyote	Up	2	1	1	1	2	2	0	50	50	0	100	50	0.06	0.1	0.009	0.07	0.00	0.00	100	1.12
Rock (Twin S-8)	Up	3	2	1	2	2	2	1	33	66	0	66	66	0.06	1.3	0.040	1.04	0.02	0.30	6	0.874
Little Jack's	Lo	2	2	0	1	2	2	0	0	50	0	100	50	0.21	1.0	0.101	0.66	0.00	0.00	60	0.73
Big Jack's (upper)	Lo	4	4	0	1	3	1	3	0	25	0	75	25	1.02	8.9	0.027	0.37	0.99	7.53	30	0.86
Cottonwood	Lo	1	1	0	1	1	1	0	0	100	0	100	100	0.23	4.8	0.225	4.75	0.00	0.00	0	0.86
Lake Fork	Lo	3	3	0	1	3	2	1	0	33	0	100	33	0.13	0.7	0.052	0.46	0.08	0.11	0	0.85
Station Fork	Lo	4	3	1	2	3	4	0	25	50	0	75	50	0.08	2.5	0.044	2.32	0.00	0.00	0	0.95
Big Willow	Lo	4	4	0	1	3	1	3	0	25	0	75	25	0.20	3.3	0.048	2.54	0.15	0.71	18	1.02
Cold Springs	Lo	2	2	0	1	2	1	1	0	50	0	100	50	0.23	3.0	0.200	2.96	0.03	0.08	0	0.92
Current	Up	2	2	0	0	2	1	1	0	0	0	100	0	0.03	0.0	0.000	0.00	0.01	0.02	0	NA
Duncan (upper)	Lo	1	1	0	1	1	1	0	0	100	0	100	100	0.75	8.6	0.750	8.57	0.00	0.00	10	1.29
Spring	Lo	4	4	0	1	3	1	3	0	25	0	75	25	3.08	8.6	0.894	2.67	2.19	5.96	50	1.07
Sheep	Im	2	2	0	0	2	0	2	0	0	0	100	0	0.19	0.3	0.000	0.00	0.19	0.30	0	NA
Big Jack's (lower)	Im	4	4	0	1	3	1	3	0	25	0	75	25	0.29	5.3	0.016	1.06	0.27	4.26	0	0.78
Cassia	Im	4	4	0	1	4	2	2	0	25	0	100	25	0.15	1.7	0.002	0.72			0	1.02
Mary's	Im	2	2	0	0	2	0	2	0	0	0	100	0	0.12	0.1	0.000	0.00	0.12	0.10	0	NA
Trapper (lower)	Im	2	2	0	1	2	1	1	0	50	0	100	50	0.03	2.3	0.010	1.98	0.02	0.28	0	1.05
Shoshone	Im	6	5	1	0	5	1	5	17	17	17	83	0	0.28	7.7	0.000	0.00	0.27	7.65	0	NA
SF Mink (Poc.)	Im	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.0	0.000	0.00	0.00	0.00	0	NA
Wolverine	Im	1	1	0	1	1	1	0	0	100	0	100	100	0.08	3.4	0.075	3.37	0.00	0.00	6	1.21
Camas	Im	3	3	0	0	2	0	3	0	0	0	66	0	0.10	0.3	0.000	0.00	0.10	0.27	0	NA
Deep	Im	5	5	0	1	4	2	3	0	20	0	80	20	0.95	1.2	0.008	0.05	0.28	1.14	0	1.14
Rock (Magic)	Im	2	2	0	1	2	2	0	0	50	0	100	50	0.04	0.3	0.015	0.05	0.00	0.00	100	0.81
Rock (Twin S-5)	Im	3	3	0	0	2	0	3	0	0	0	66	0	0.06	0.3	0.000	0.00	0.06	0.30	0	0.959
Rock (Twin S-6)	Im	2	2	0	1	2	1	1	0	50	0	100	50	0.01	0.2	0.002	0.08	0.01	0.07	0	1.06

SUMMARY	TYPE	SPECIES RICH	NUMBER NATIVE SPECIES	NUM INTRO(a) SPECIES	NUM SALMON SPECIES	NUM BENTHIC INSECT.	NUM INTOL(b) SPECIES	NUM TOL(c) SPECIES	% INTRO SPECIES	% CARNI	% OMNIV	% INSECT	% SALMON	DENS (#/m2)	BIOM (g/m2)	SALMON DENS	SALMON BIOM	TOLER DENS	TOLER BIOM	% YOY	COND FACTOR
UPLAND	MEAN	1.56	0.94	0.63	1.19	1.50	1.50	0.06	44	81	0	98	81	0.10	2.48	0.08	2.40	0.00	0.02	18	1.02
	STD	0.86	0.83	0.48	0.63	0.79	0.79	0.24	42	29	0	8	29	0.07	2.45	0.07	2.50	0.01	0.07	28	0.30
LOWLAND	MEAN	2.70	2.60	0.10	1.00	2.30	1.50	1.20	3	46	0	90	46	0.60	4.14	0.23	2.53	0.34	1.44	17	0.86
	STD	1.19	1.11	0.30	0.45	0.78	0.92	1.25	8	31	0	12	31	0.88	3.25	0.30	2.46	0.68	2.68	21	0.32
IMPACTED	MEAN	2.64	2.57	0.07	0.57	2.29	0.86	1.79	1	31	1	84	30	0.18	1.99	0.02	0.88	0.10	1.11	10	0.63
	STD	1.59	1.45	0.26	0.49	1.28	0.74	1.47	4	34	4	27	34	0.23	2.36	0.06	1.50	0.11	2.19	27	0.48
UP-NBR	MEAN	1.63	1.13	0.50	1.38	1.63	1.63	0.00	0.34	0.91	0.00	1.00	0.91	0.13	3.65	0.12	3.63	0.00	0.00	0.11	1.08
	STD	0.99	0.93	0.50	0.70	0.99	0.99	0.00	0.41	0.17	0.00	0.00	0.17	0.08	2.84	0.07	2.85	0.00	0.00	0.18	0.12
UP-SRP	MEAN	1.50	0.75	0.75	1.00	1.38	1.38	0.13	0.54	0.71	0.00	0.96	0.71	0.06	1.31	0.03	1.17	0.00	0.04	0.25	0.96
	STD	0.71	0.66	0.43	0.50	0.48	0.48	0.33	0.40	0.34	0.00	0.11	0.34	0.03	1.08	0.03	1.17	0.01	0.10	0.34	0.39
LO-NBR	MEAN	3.50	3.00	0.50	1.50	3.00	3.00	0.50	0.13	0.42	0.00	0.88	0.42	0.11	1.61	0.05	1.39	0.04	0.06	0.00	0.90
	STD	0.50	0.00	0.50	0.50	0.00	1.00	0.50	0.13	0.09	0.00	0.13	0.09	0.02	0.91	0.00	0.93	0.04	0.06	0.00	0.05
LO-SP	MEAN	2.50	2.50	0.00	0.88	2.13	1.13	1.38	0.00	0.47	0.00	0.91	0.47	0.72	4.78	0.28	2.82	0.42	1.79	0.21	0.84
	STD	1.22	1.22	0.00	0.33	0.78	0.33	1.32	0.00	0.34	0.00	0.12	0.34	0.95	3.32	0.32	2.63	0.74	2.90	0.22	0.36
IMP-NBR	MEAN	1.75	1.75	0.00	0.75	1.75	1.00	0.75	0.00	0.44	0.00	0.75	0.44	0.06	1.83	0.02	1.52	0.01	0.09	0.02	0.82
	STD	1.48	1.48	0.00	0.43	1.48	0.71	0.83	0.00	0.37	0.00	0.43	0.37	0.06	1.22	0.03	1.28	0.01	0.13	0.03	0.48
IMP-SRP	MEAN	3.22	3.11	0.11	0.44	2.67	0.78	2.44	0.02	0.18	0.02	0.86	0.16	0.23	1.73	0.00	0.14	0.14	1.57	0.11	0.53
	STD	1.40	1.20	0.31	0.50	1.05	0.79	1.34	0.05	0.19	0.05	0.14	0.20	0.27	2.63	0.01	0.33	0.11	2.50	0.31	0.48

a = introduced, b=intolerant, c=tolerant (Chandler and Maret 1991).

Table 8. Number of fish collected by electrofishing streams in the Snake River Plain and Northern Basin and Range Ecoregions.

STREAM	TYPE	#	DATE COLLECTED	RAINBOW TROUT	BROOK TROUT	CUTTHROAT TROUT	BROWN TROUT	MOTTLED SCULPIN	TORRENT SCULPIN	REDSIDE SHINER	MOUNTAIN SUCKER	BLUEHEAD SUCKER	SPECKLED DACE	LONGNOSE DACE	CHISEL-MOUTH	SMALLMOUTH BASS
TOLERANCE (a)				I	MI	I	MI	MI	I	MI/MT	MT	MT	MI/MT	MI/MT	T	MI/MT
TROPHIC GUILD (b)				I/C	I/C	I/C	C	I	I	I	H	I	I	I	O	C
NATIVE/INTRODUCED				N	I	N	I	N	N	N	N	N	N	N	N	I
Green	Up	1	900614	1	10											
Stinson	Up	2	900614		8											
Trapper (upper)	Up	3	900615	12				1								
Buck	Up	4	900620	7												
Cottonwood	Up	5	900614	13	10	1		9								
3rd Fork	Up	8	900717	42												
Bloomington	Up	35	910629	1												
Mink (Preston)	Up	36	910629		54											
WF Mink (Poc.)	Up	37	910627			2										
Timber	Up	38	910829		17											
SF Soldier	Up	39	910624		5			5								
Cherry	Up	40	910801		2			12								
Bear	Up	41	910830		5											
Ramey	Up	42	910830		2											
Coyote	Up	43	910801		1			5								
Rock (Twin S-8)	Up	56	900214	18			1						11			
Little Jack's	Lo	15	900721	10				11								
Big Jack's (upper)	Lo	16	900825	3						55	12			42		
Cottonwood	Lo	17	900826	9												
Lake Fork	Lo	18	900613	1					1	3						
Station Fork	Lo	19	900613	9			4	6	5							
Big Willow	Lo	44	910624	17						1	5		46			
Cold Springs	Lo	45	910623	18									3			
Current	Up	46	910621					4					1			
Duncan (upper)	Lo	47	910622	39												
Spring	Lo	48	910625	76						18	21		147			
Sheep	Im	26	900620							19			19			
Big Jack's (lower)	Im	27	900619	5						17	35		34			
Cassia	Im	28	900618	1				47		11				2		
Mary's	Im	29	900720							24				5		
Duncan (lower)	Im	30	900815	17												
Trapper (lower)	Im	31	900621	2										4		
Shoshone	Im	32	900619					2		31		20	3		2	1
SF Mink (Poc.)	Im	49	910627													
Wolverine	Im	50	910627			9										
Camas	Im	51	910623							55	4		8			
Deep	Im	52	910621	2				1		57	50		58			
Rock (Magic)	Im	53	910623	3				4								
Rock (Twin S-5)	Im	54	900214							4	3		38			
Rock (Twin S-6)	Im	55	900214	1									7			

a - Tolerance designations: I=Intolerant, MI=Moderately Intolerant, MT=Moderately Tolerant (Chandler and Maret 1991).
b - Tropic guilds: I=Invertivore, C=Carnivore, O=Omnivore

mean absolute value (i.e., mean+95%CL). A score of 3 was recorded if the absolute value fell within the mean absolute value and mean+95%CL value, whereas a score of 1 was recorded for absolute values that were less than the mean absolute value.

Important metrics, for macroinvertebrates and fish, to distinguish among stream types and between ecoregions were determined using Multiple Discriminant Analysis (MDA) and Principal Components Analysis (PCA) using the Statistica software package (Statsoft: Statistica 1991). Once the important metrics were determined for macroinvertebrates or fish, metric criteria scores were summed for each site and regressed against respective habitat assessment scores. Additional regressions were completed for summed metric scores against habitat assessment scores by ecoregion. ANOVA was used to test for differences between the summed criteria metric scores among stream types and between ecoregions (Zar 1984). The post hoc Student Newman Kuels (SNK) test was used to determine differences among means.

Quantitative versus Qualitative Sampling: Metric scores derived from the quantitative macroinvertebrate samples were compared with metric scores derived from the qualitative samples. Linear regression was completed on the quantitatively-based metric scores against respective qualitatively-based metric scores. In addition, separate regressions were completed for quantitative and qualitative metric scores against habitat assessment scores. Fish abundance was quantified using the Zippin 3-pass method. Analyses consisted of regressing 1st-pass abundance against the estimated total abundance for a site.

RESULTS

Habitat Assessment and Evaluation: Habitat assessment scores based on the subjective categorical criteria averaged 160 (range 142-172) for upland sites, 146 (range 111-173) for lowland sites, and 87 (range 27-111) for impacted sites (Table 5). Maximum possible score was 180. In order to reduce the subjective nature of this scoring system and to provide a compromise with quantitative habitat measures, we completed a multiple discriminant analysis to distinguish among stream types using both the qualitative (Table 4) and quantitative (Table 3) measures. This analysis was further used to separate stream types by the two ecoregions. Based on the results of the MDA (Appendix B), six of the twelve subjective measures and ten of the twenty quantitative measures were found important to distinguish among stream types between ecoregions ($F=8.98$, $p=0.0000$)(Table 5). Criteria scores of the selected subjective categories were retained, and criteria scores were developed to standardize quantitative categories. A maximum score of 15 was used to indicate optimal habitat (range 11-15) for these quantitative categories (Table 5). Marginal habitat was indicated with scores between 6-10, and poor habitat with scores between 0-5. The absolute values of habitat measures with respective criteria scores can be found in Table 5. The criteria scores were summed for a habitat assessment score for each site.

A maximum score of 235 was possible with the revised habitat evaluation procedure (Table 5). Modified habitat scores for upland sites ranged from 125 to 217, for lowland sites from 87 to 184, and for impacted sites from 51 to 107 (Fig. 1). The regression of the subjective habitat score against the refined habitat assessment score was $r^2=0.67$ (Fig. 2). This relatively low r-square suggests that the inclusion of quantitative measures added important information for evaluating stream/riparian habitats between ecoregions. For example, impacted sites had higher temperatures and nutrient levels than upland sites resulting in lower habitat scores for these variables (Figs. 3-5). In addition, the SRB ecoregion had lower values of specific conductance than NBR ecoregion resulting in higher habitat scores

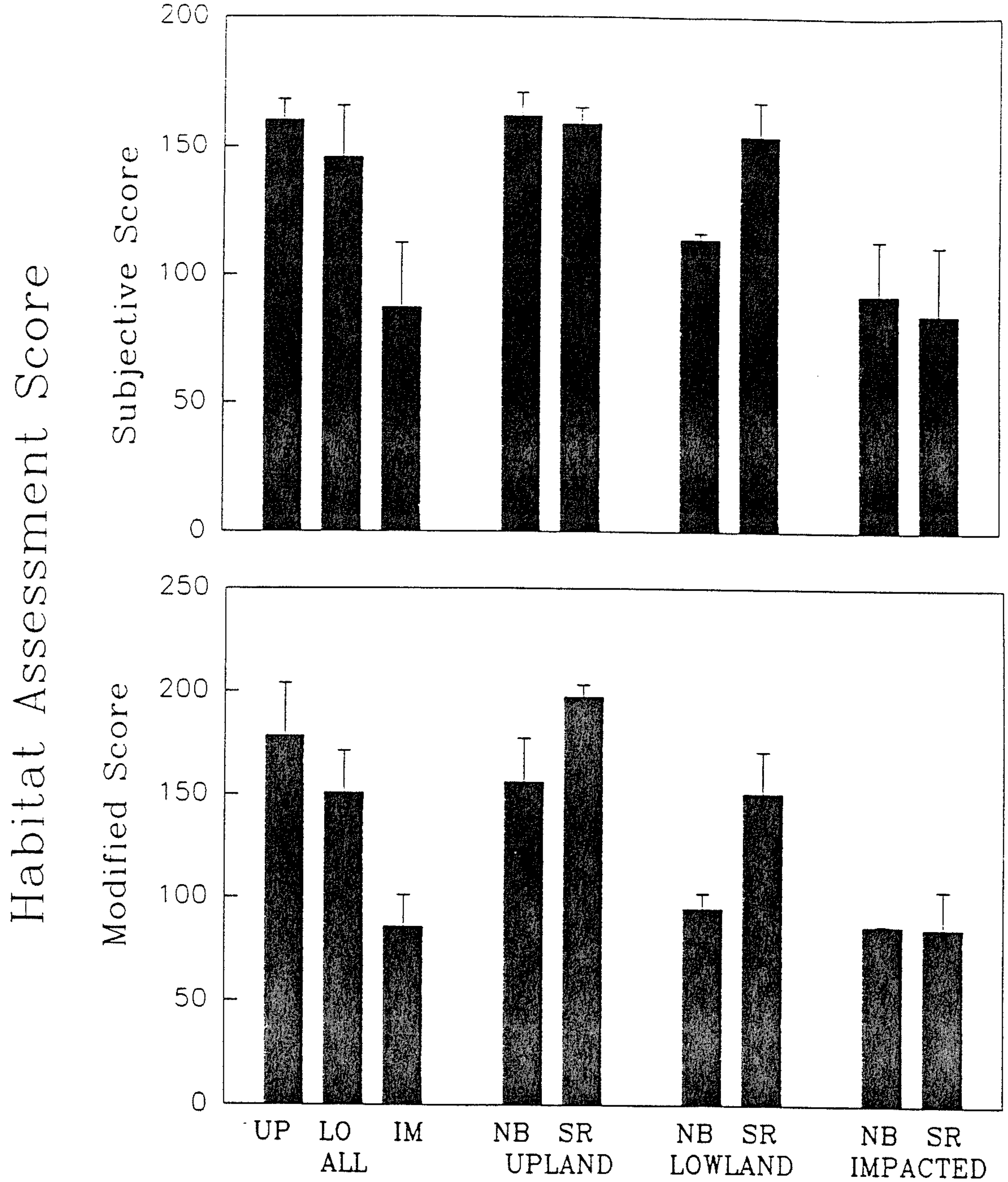


Fig. 1. Subjective and modified habitat assessment scores for upland (UP), lowland (LO), and impacted (IM) stream sites (NB=Northern Basin, SR=Snake River Plain ecoregions) Vertical bars represent one standard deviation from the mean.

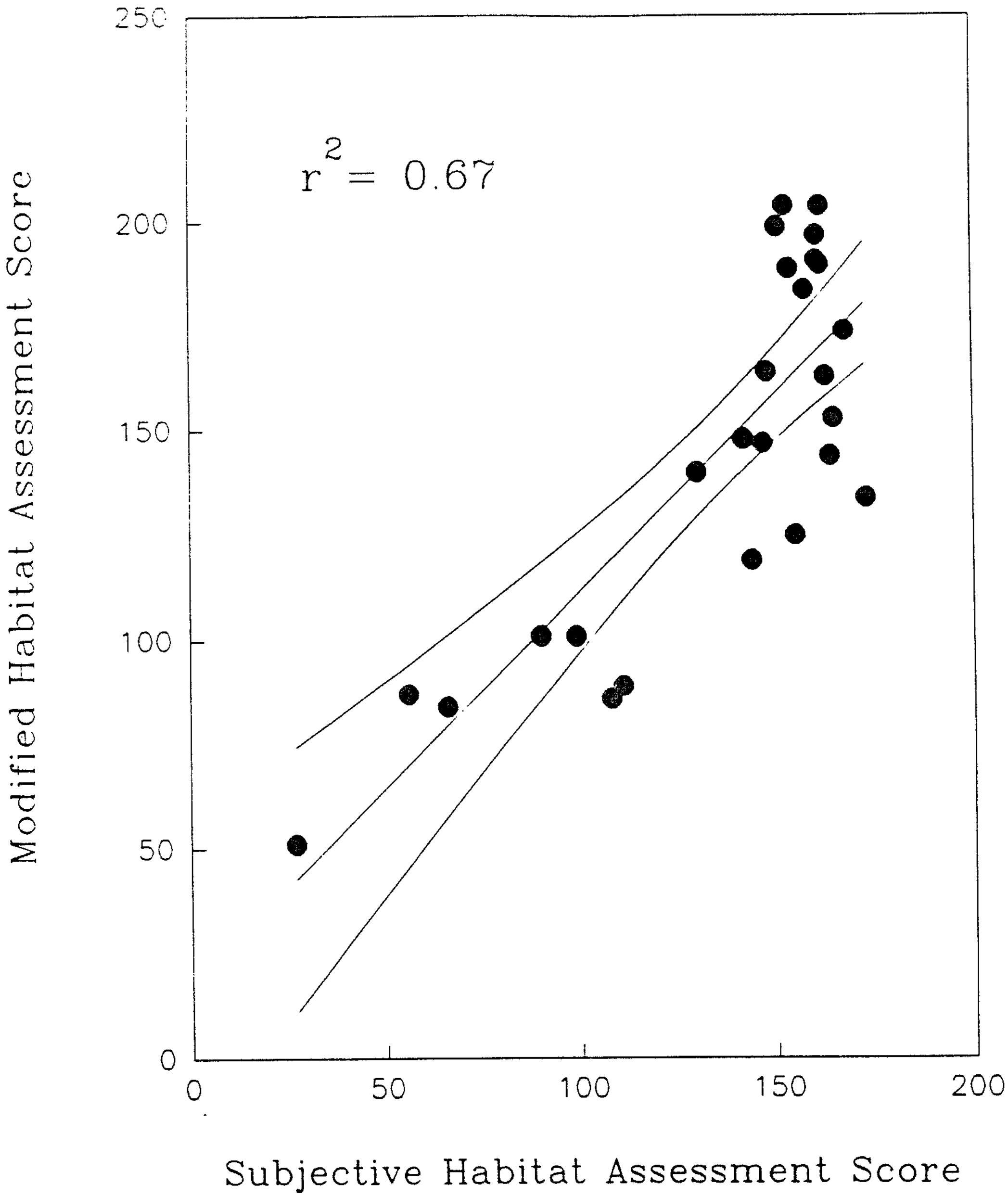


Fig. 2. Modified habitat assessment score regressed against the original unmodified habitat assessment score. Outer diagonal lines represent 95% confidence limits.

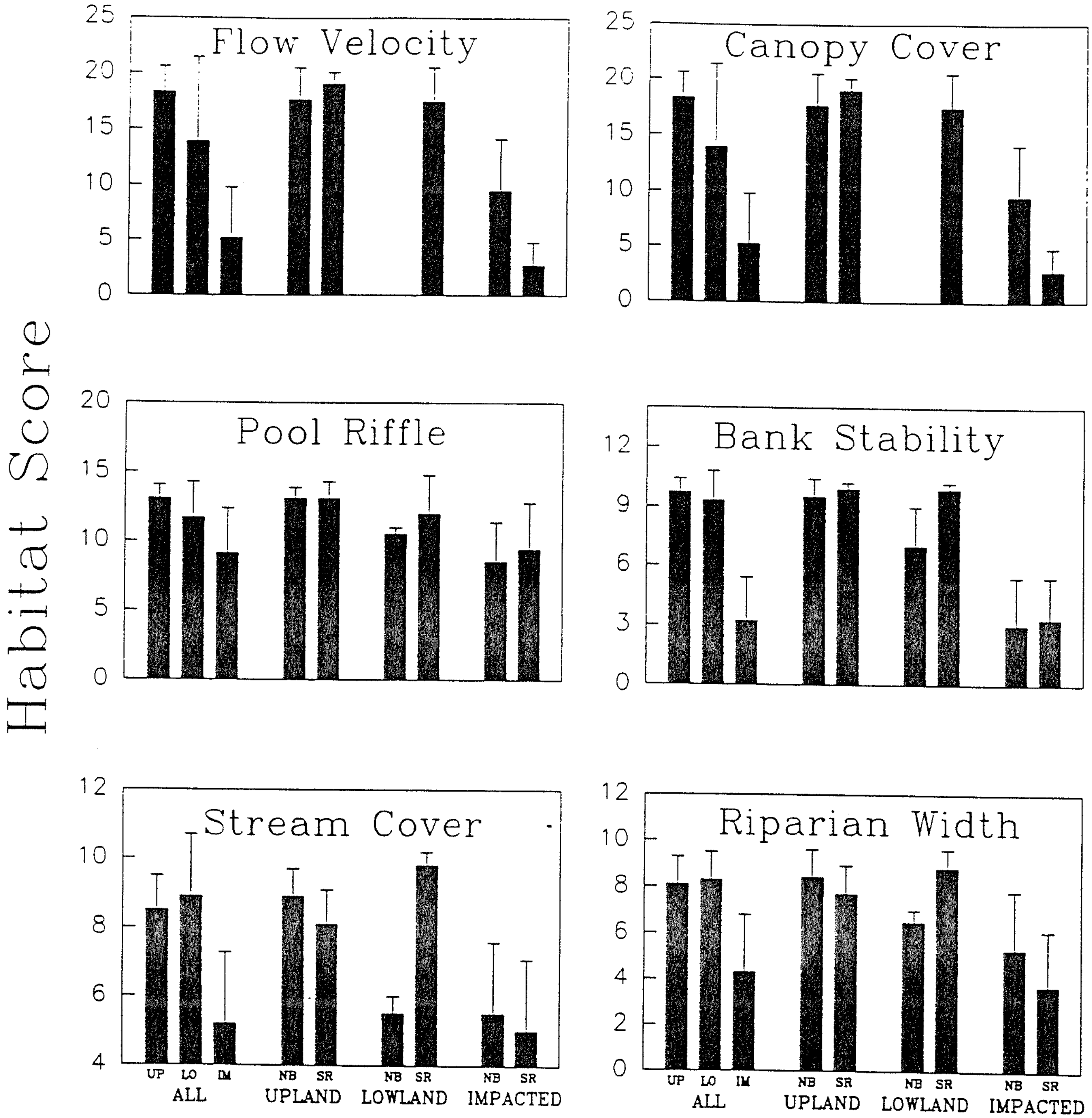


Fig. 3. Qualitative categories and respective scores for upland, lowland, impacted and all sites pooled for Northern Basin and Range (NB) and Snake River Plain Ecoregion (SR) streams. Scores of zero were obtained for flow velocity and canopy cover at NB lowland sites.

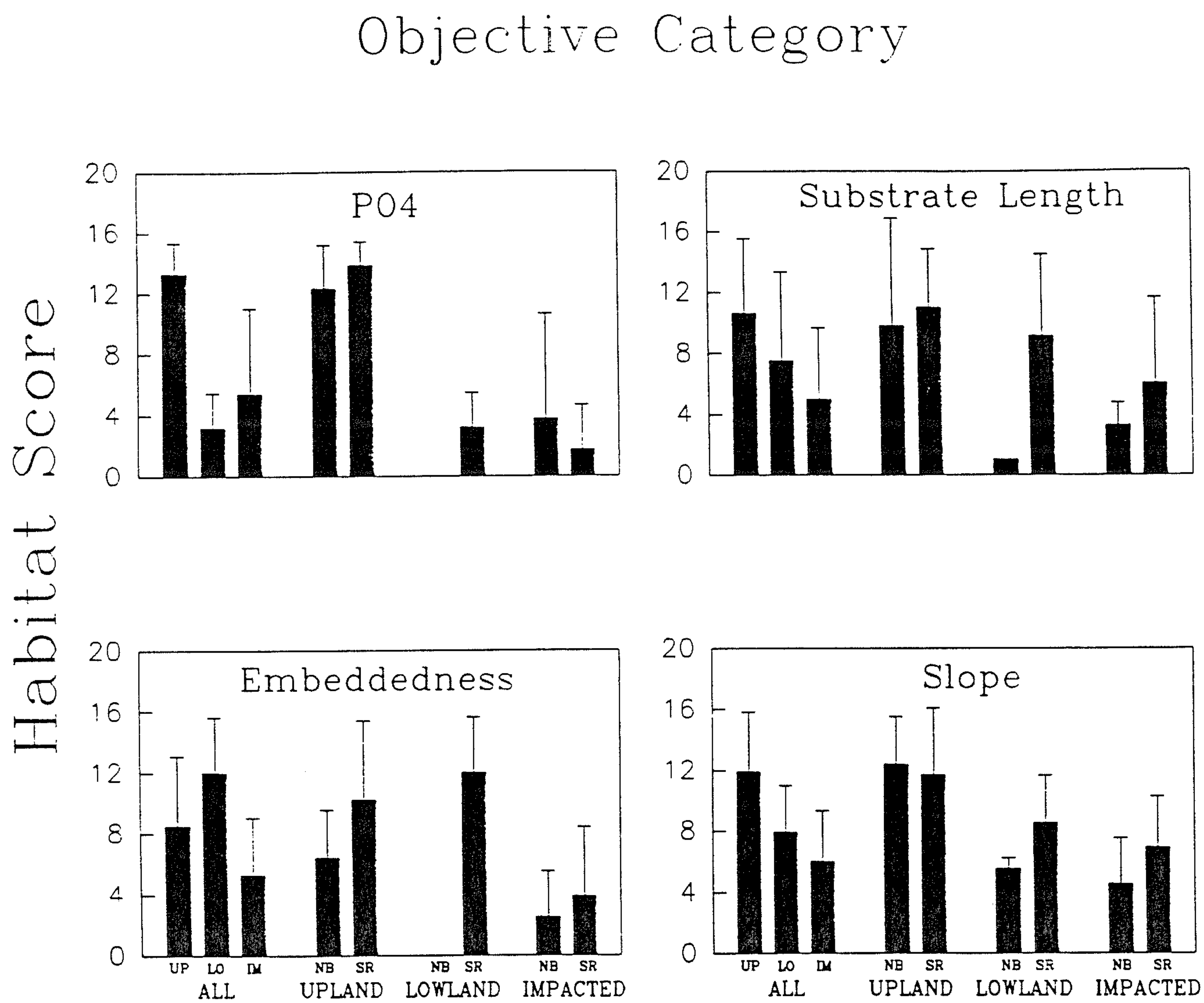


Fig. 4. Objective categories for upland, lowland, impacted and all sites pooled for Northern Basin and Range (NB) and Snake River Plain Ecoregion (SR) streams. Embeddedness and P04 was not measured at lowland and NB sites.

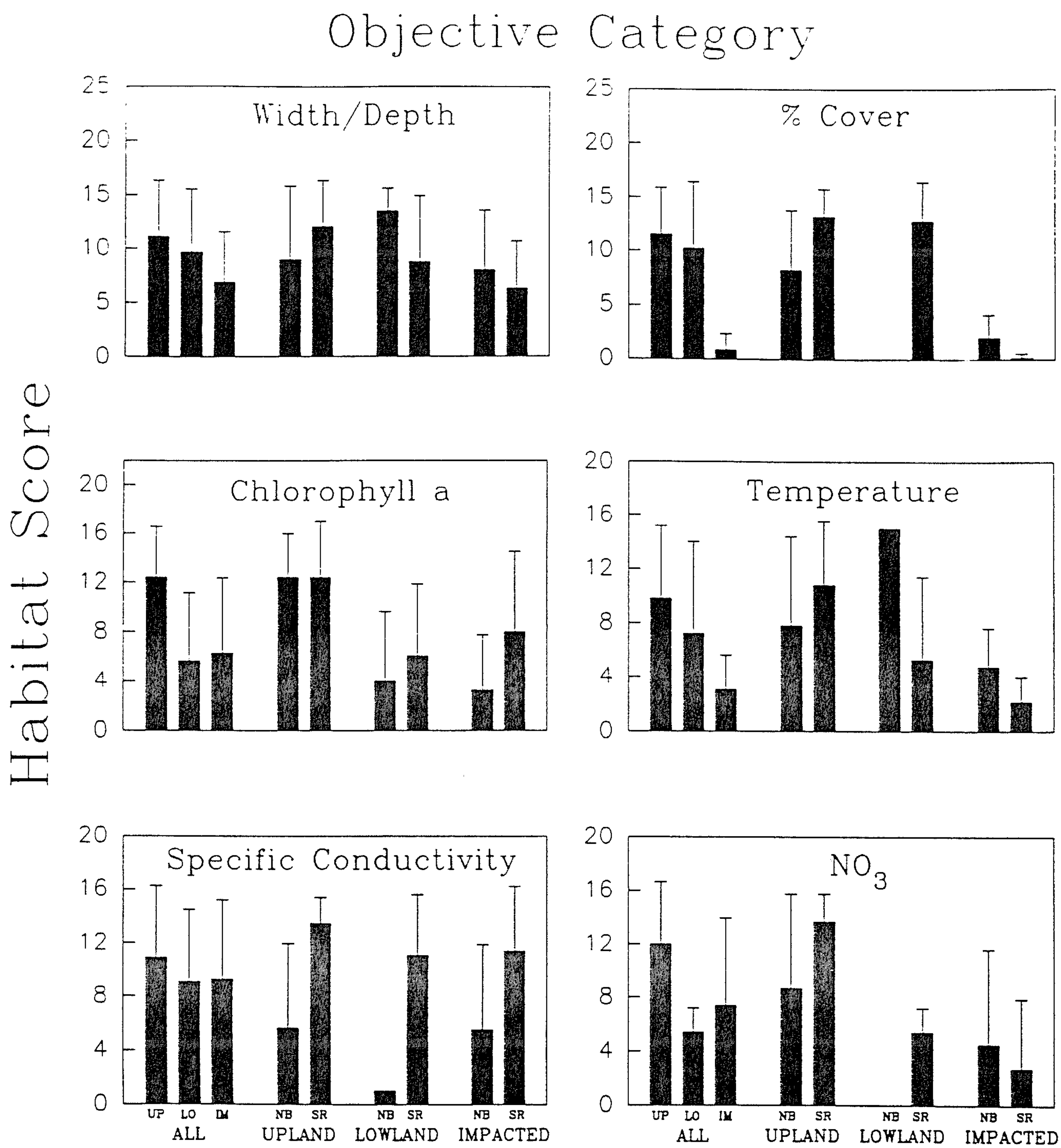


Fig. 5. Quanitative categories and respective scores for upland, lowland, impacted and all sites pooled for Northern Basin and Range (NB) and Snake River Plain Ecoregion (SR) streams. A score of zero was obtained for % cover, and NO_3 was not measured at lowland Northern Basin sites.

for this variable in the SRP (Fig. 4). These habitat variables were effective in separating stream types based on the multiple discriminant analysis (Fig. 6). Its important to note that the inclusion of these quantitative measures added very little time to field procedures.

Macroinvertebrate Metric Development: Seven community level metrics were found important (based on PCA, MDA (Appendix C), and multiple linear regression results) for discriminating among stream types: EPT richness, HBI index, % dominance, Shannon's (H') diversity, Simpson's index, % Filterers, and % EPT taxa (Fig. 7). These metrics resulted in a maximum summed score of 35 (Table 9). Scores ranged from 7 to 35 for upland streams, from 11 to 25 for lowland sites, and from 7 to 21 for impacted streams. EPT richness was greater in upland than lowland and impacted streams (Fig. 8). The HBI index, % dominance, Simpson's index, and % Filterers were highest in impacted streams than in upland and lowland streams. Shannon's (H') diversity was similar in upland and lowland streams, and lowest in impacted streams.

The macroinvertebrate metric score displayed a positive regression against the habitat assessment score (r^2=0.37) using all sites analyzed (Fig. 9). The average metric score was highest in upland streams (mean=23), and lowest in impacted streams (mean=13)(Fig. 10). Average macroinvertebrate metric scores were similar between ecoregions for each stream type. The regression of the macroinvertebrate metric score against the habitat assessment score for each ecoregion displayed almost identical relationships (r^2=0.46 for NBR, r^2=0.44 for SRP)(Fig. 11). Regression slopes were essentially the same (NBR, 0.14; SRP, 0.11).

Metric scores derived from qualitative samples were regressed against samples collected quantitatively from the same site. Similar metric scores were derived from either sampling method

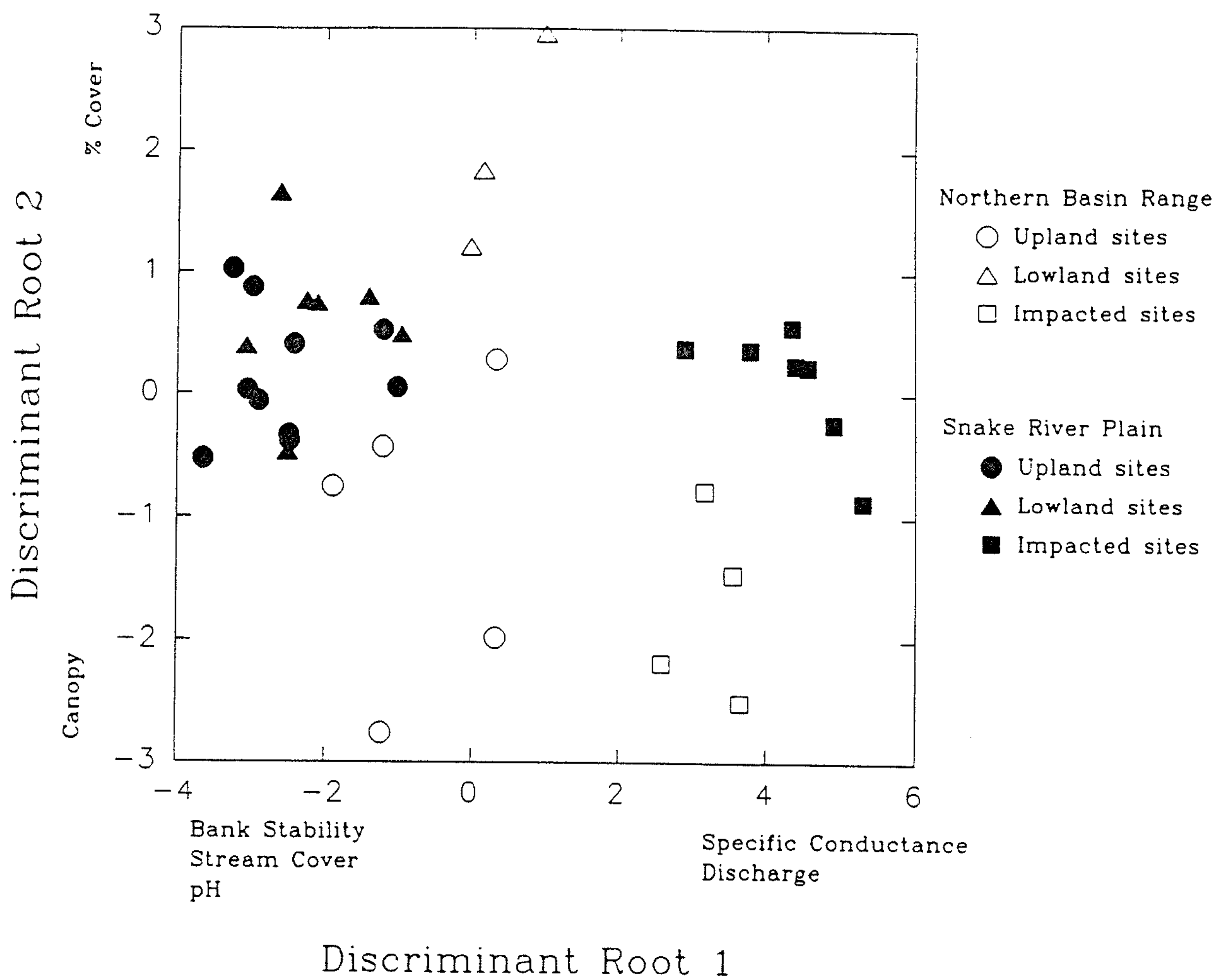


Fig. 6. Discriminant scatterplot of habitat categories for Northern Basin and Range and Snake River Plain ecoregions. See appendix B for values of root scores and statistical summary.

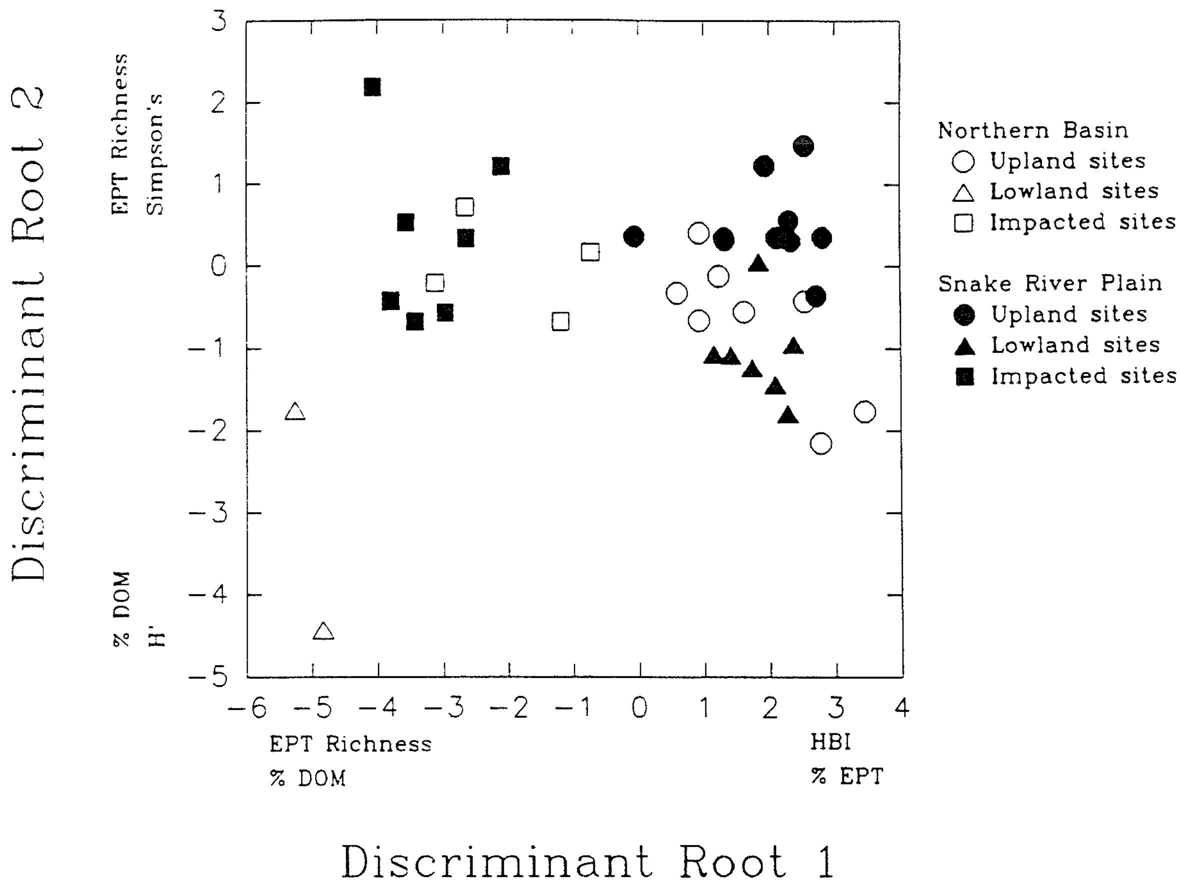


Fig. 7. Discriminant scatterplot of macro-invertebrate metrics for the Northern Basin and Range and Snake River Plain ecoregions. See appendix C for values of root scores and statistical summary.

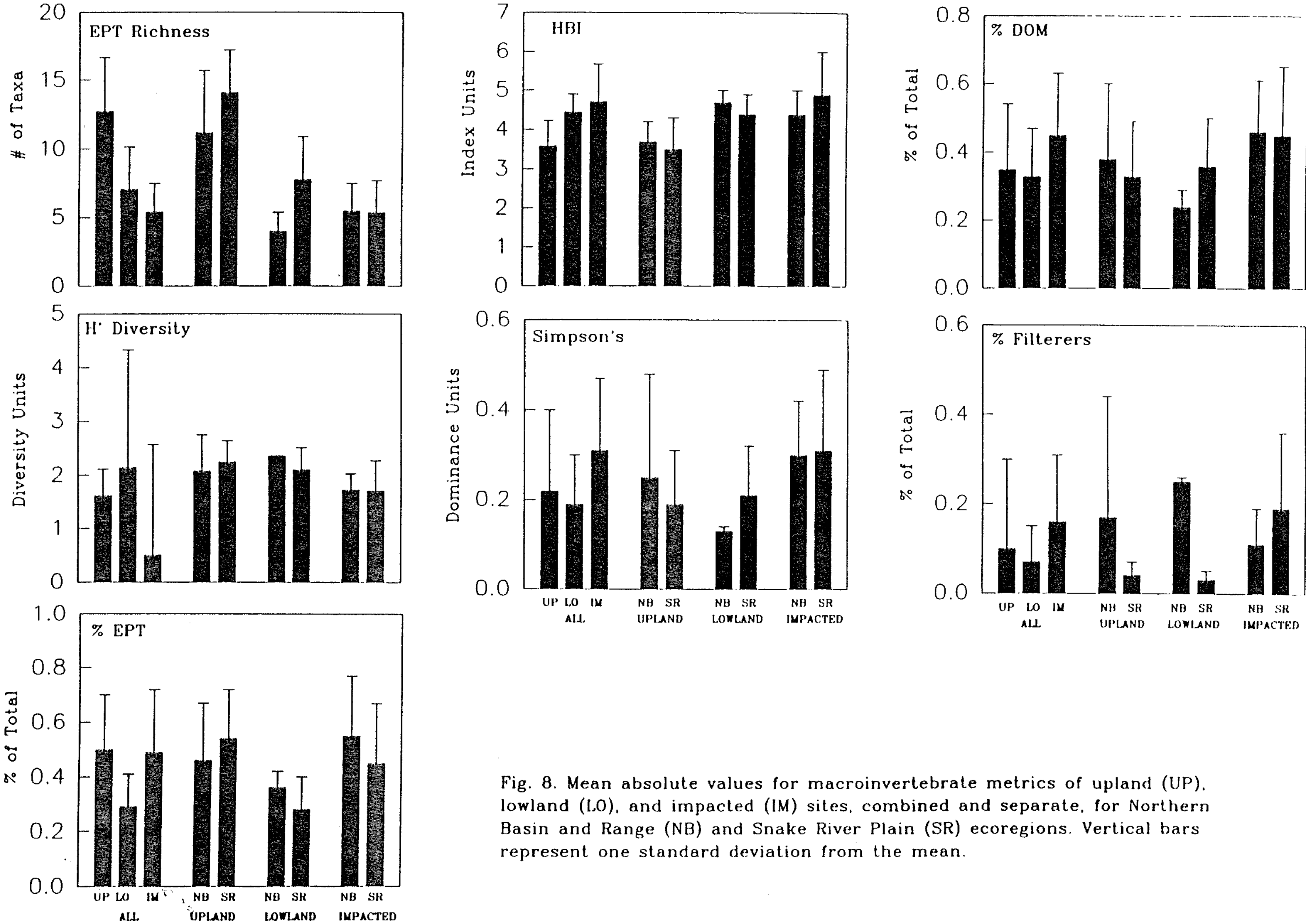


Fig. 8. Mean absolute values for macroinvertebrate metrics of upland (UP), lowland (LO), and impacted (IM) sites, combined and separate, for Northern Basin and Range (NB) and Snake River Plain (SR) ecoregions. Vertical bars represent one standard deviation from the mean.

Table 9. Absolute values and respective scores for macroinvertebrate metrics used for refined biotic index.

TYPE	#	REP #	NBR/SRB	EPT RICHNESS	SCORE	HBI INDEX	SCORE	% DOM	SCORE	H' DIVERSITY	SCORE	SIMPSON'S INDEX	SCORE	% FILTERERS	SCORE	% EPT	SCORE	MODIFIED SCORE MAX=35
Up	1	QUAL.	1	17	5	3.28	5	0.20	5	2.71	5	0.10	5	0.16	1	0.85	5	31
Up	2	QUAL.	1	4	1	3.04	5	0.92	1	0.45	1	0.85	1	0.92	1	0.05	1	11
Up	3	QUAL.	1	8	1	4.18	1	0.56	1	1.67	1	0.36	1	0.07	3	0.31	1	9
Up	4	QUAL.	2	7	1	3.16	5	0.33	3	1.91	1	0.21	3	0.07	3	0.53	3	19
Up	5	QUAL.	1	12	1	4.41	1	0.36	3	2.21	1	0.18	5	0.11	1	0.46	1	13
Up	8	QUAL.	1	8	1	4.24	1	0.45	1	1.85	1	0.25	1	0.18	1	0.28	1	7
Up	37	QUAL.	1	11	1	3.01	5	0.16	5	2.66	5	0.09	5	0.01	5	0.67	5	31
Up	39	QUAL.	2	13	3	1.96	5	0.32	5	2.15	1	0.19	3	0.03	5	0.92	5	27
Up	40	QUAL.	2	15	5	2.75	5	0.14	5	2.73	5	0.08	5	0.08	3	0.76	5	33
Up	43	QUAL.	2	14	3	4.19	1	0.27	5	2.50	5	0.14	5	0.07	3	0.58	3	25
Up	35	QUAN.	1	9	1	4.14	1	0.26	5	2.08	1	0.17	5	0.01	5	0.59	3	21
Up	36	QUAN.	1	15	5	3.36	5	0.26	5	2.50	5	0.13	5	0.05	5	0.75	5	35
Up	37	QUAN.	1	17	5	3.74	3	0.28	5	2.57	5	0.13	5	0.04	5	0.41	1	29
Up	38	QUAN.	2	12	1	3.57	5	0.14	5	2.56	5	0.10	5	0.00	5	0.53	3	29
Up	39	QUAN.	2	13	3	4.26	1	0.71	1	1.34	1	0.51	1	0.00	5	0.22	1	13
Up	40	QUAN.	2	16	5	3.94	1	0.27	5	2.36	3	0.14	5	0.02	5	0.50	1	25
Up	41	QUAN.	2	17	5	3.19	5	0.25	5	2.52	5	0.12	5	0.09	1	0.49	1	27
Up	42	QUAN.	2	18	5	3.60	5	0.49	1	2.06	1	0.27	1	0.01	5	0.40	1	19
Up	43	QUAN.	2	16	5	4.07	1	0.32	5	2.43	5	0.15	5	0.03	5	0.49	1	27
																		0
Lo	15	QUAL.	2	7	1	4.13	1	0.22	5	2.45	5	0.11	5	0.06	5	0.29	1	23
Lo	16	QUAL.	2	7	1	4.68	1	0.39	1	2.24	1	0.21	3	0.04	5	0.14	1	13
Lo	17	QUAL.	2	10	1	4.14	1	0.29	5	2.23	1	0.16	5	0.02	5	0.50	1	19
Lo	18	QUAL.	1	3	1	4.49	1	0.18	5	2.37	3	0.12	5	0.24	1	0.31	1	17
Lo	19	QUAL.	1	5	1	4.93	1	0.29	5	2.35	3	0.13	5	0.25	1	0.42	1	17
Lo	48	QUAL.	2	6	1	4.42	1	0.36	3	1.94	1	0.21	3	0.01	5	0.32	1	15
Lo	44	QUAN.	2	9	1	4.17	1	0.43	1	1.99	1	0.23	1	0.04	5	0.25	1	11
Lo	45	QUAN.	2	11	1	3.79	3	0.21	5	2.48	5	0.12	5	0.05	5	0.33	1	25
Lo	46	QUAN.	2	11	1	3.95	1	0.22	5	2.33	3	0.13	5	0.05	5	0.33	1	21
Lo	47	QUAN.	2	1	1	5.45	1	0.69	1	1.05	1	0.51	1	0.00	5	0.03	1	11
Lo	48	QUAN.	2	8	1	4.67	1	0.40	1	2.18	1	0.19	3	0.03	5	0.28	1	13
																		0
Im	26	QUAL.	2	5	1	5.49	1	0.48	1	1.62	1	0.31	1	0.48	1	0.15	1	7
Im	27	QUAL.	2	9	1	3.81	3	0.21	5	2.44	3	0.12	5	0.21	1	0.53	3	21
Im	28	QUAL.	1	5	1	4.29	1	0.32	5	2.11	1	0.18	5	0.12	1	0.31	1	15
Im	29	QUAL.	2	5	1	5.20	1	0.38	3	2.22	1	0.19	3	0.14	1	0.31	1	11
Im	31	QUAL.	1	5	1	3.26	5	0.28	5	2.09	1	0.17	5	0.25	1	0.60	3	21
Im	32	QUAL.	2	7	1	4.61	1	0.12	5	2.73	5	0.08	5	0.29	1	0.45	1	19
Im	49	QUAL.	1	5	1	4.82	1	0.93	1	1.49	1	0.42	1	0.02	5	0.75	5	15
Im	50	QUAL.	1	6	1	4.65	1	0.42	1	1.84	1	0.25	1	0.11	1	0.56	3	9
Im	51	QUAL.	2	4	1	3.25	5	0.47	1	1.49	1	0.31	1	0.05	5	0.76	5	19
Im	52	QUAL.	2	4	1	4.49	1	0.64	1	1.42	1	0.43	1	0.01	5	0.74	5	15
Im	53	QUAL.	2	3	1	4.93	1	0.45	1	1.44	1	0.30	1	0.48	1	0.33	1	7
Im	49	QUAN.	1	3	1	5.20	1	0.40	1	1.48	1	0.28	1	0.01	5	0.24	1	11
Im	50	QUAN.	1	9	1	4.43	1	0.69	1	1.36	1	0.48	1	0.13	1	0.86	5	11
Im	51	QUAN.	2	4	1	4.27	1	0.30	5	1.68	1	0.22	3	0.11	1	0.46	1	13
Im	52	QUAN.	2	10	1	4.77	1	0.52	1	1.66	1	0.32	1	0.02	5	0.64	5	15
Im	53	QUAN.	2	5	1	4.87	1	0.45	1	1.52	1	0.30	1	0.31	1	0.55	1	7
Im	54	QUAN.	2	3	1	7.69	1	0.90	1	0.54	1	0.81	1	0.04	5	0.03	1	11

	SCORE	EPT RICHNESS	HBI INDEX	% DOM	H' DIVERSITY	SIMPSON'S INDEX	% FILTERERS	% EPT
	5	>14.6	<3.59	<0.32	>2.45	<0.18	<0.06	>0.61
	3	12.7-14.6	3.59-3.90	0.32-0.38	2.26-2.45	0.18-0.22	0.06-0.08	0.53-0.61
	1	<12.6	>3.90	>0.38	<2.26	>0.22	>0.08	<0.53
UPLAND N=19	MEAN	12.74	3.59	0.32	2.26	0.18	0.06	0.53
	STDERR	0.89	0.15	0.03	0.09	0.02	0.01	0.04
	95% CL	1.87	0.31	0.06	0.19	0.04	0.02	0.08
	MEAN+CL	14.60	3.90	0.38	2.45	0.22	0.08	0.61

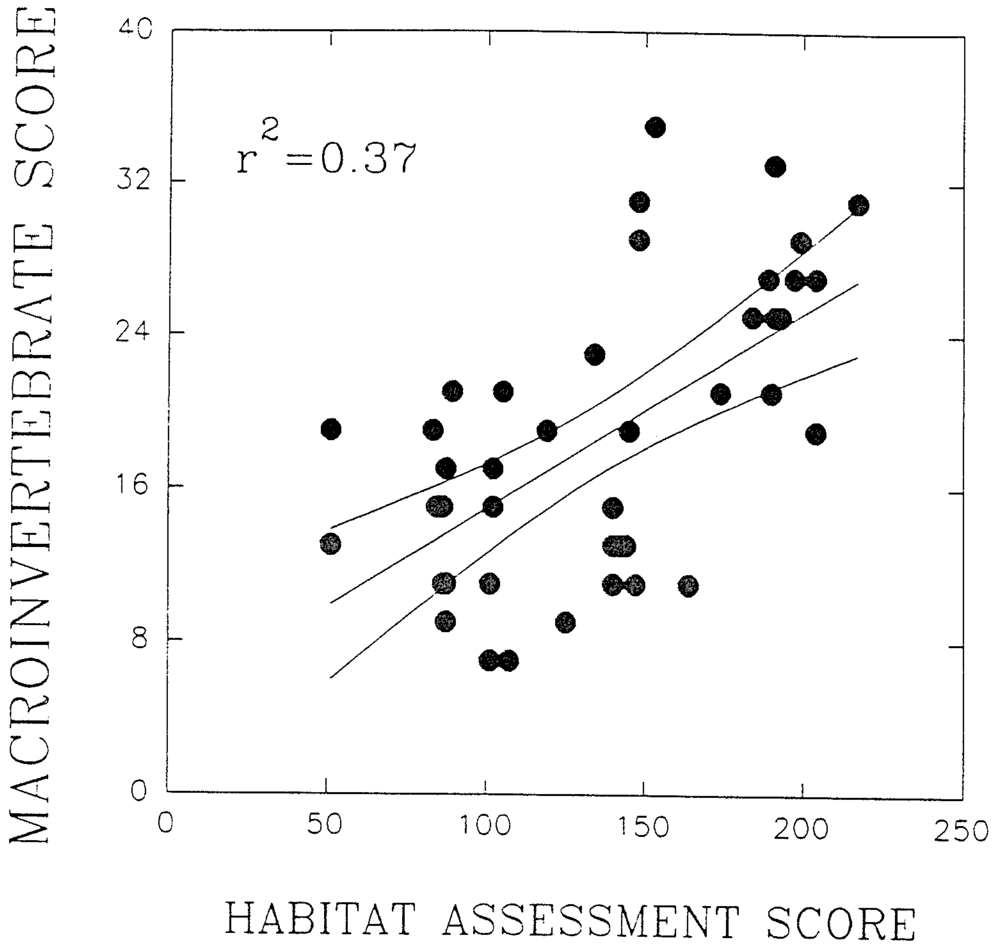


Fig. 9. Regression of the refined macro-invertebrate metric score (based on seven metrics) against the habitat assessment score. Regression line bounded by 95% CL.

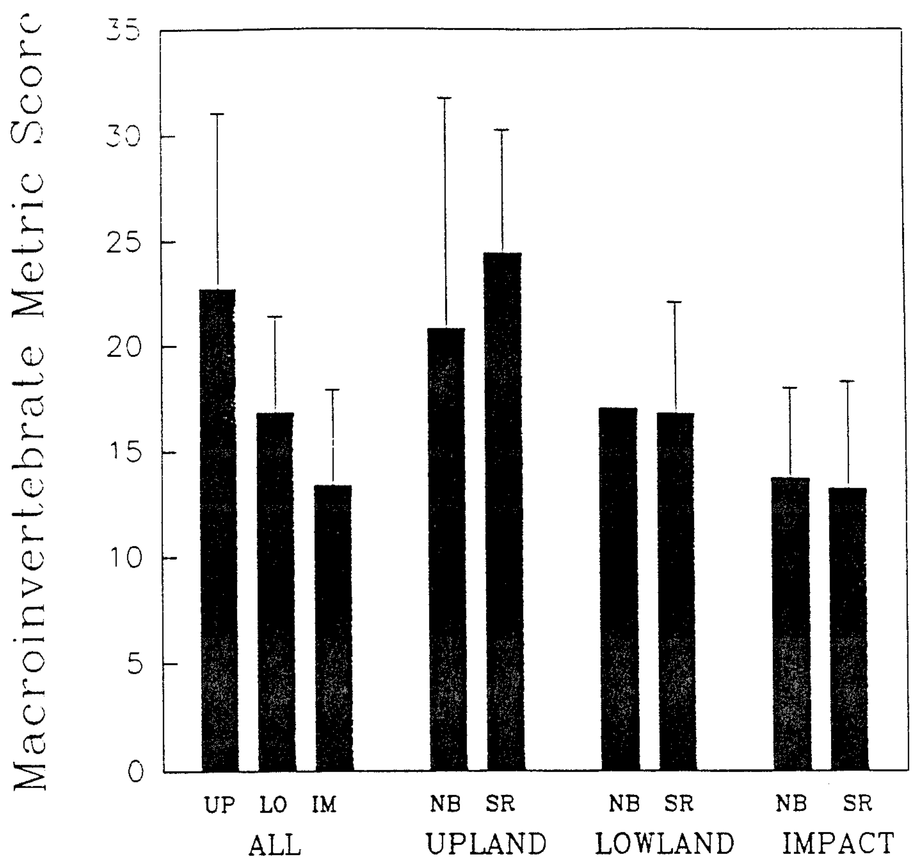


Fig. 10. Mean macroinvertebrate metric scores (separate and combined) of upland (UP), lowland (LO), and impacted (IM) sites for Northern Basin and Range (NB) and Snake River Plain (SR) ecoregions. Vertical bars represent one standard deviation from the mean.

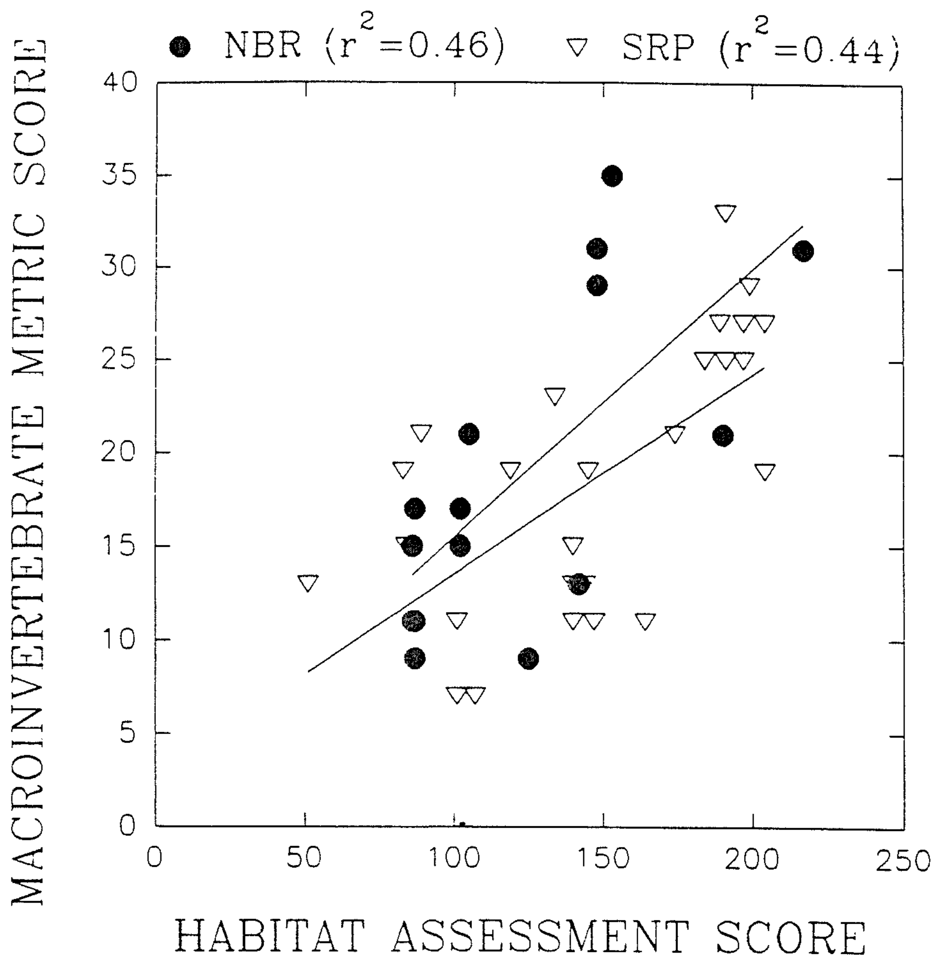


Fig. 11. Regression of the macroinvertebrate metric score against the habitat assessment score for the Northern Basin and Range (NBR), and Snake River Plain (SRP) ecoregions.

(r^2=0.87)(Fig. 12), however macroinvertebrate density and biomass could not be determined from qualitative samples. These are two parameters of functional significance. Qualitative scores were somewhat lower than quantitative scores for upland sites, similar for lowland sites, and somewhat higher for impacted sites (Fig. 13). This resulted in greater separation among stream types using a quantitative sampling approach (mean score range=12-25) than with qualitative samples (mean score range=14-20). Further, the regression of the metric score derived from quantitative samples provided a better fit (r^2=0.30) against the habitat assessment score than the metric score derived from qualitative samples (r^2=0.19)(Fig. 14).

Macrinvertebrate Taxa Analysis: Multiple Discriminant Analysis (MDA) and Principal Components Analysis (PCA) were completed from 45 taxa that comprised at least 5% of the assemblage at a site (Table 10). Twelve taxa from this list were found important in distinguishing among stream types based on the MDA (Appendix D) and PCA results: *Simulium*, *Baetis*, Turbularians, Elmidae, *Rhyacophila*, Hydracarina, *Ephemerella*, Pisidium, *Alloperla*, *Hexatoma*, and *Antocha* (Fig. 15). However, some other taxa appeared to be more prevalent at upland sites, e.g., *Rhithrogena, Zapada, Capnia, Micrasema, Rhyacophila acropedes,* and *Drunella doddsi*. In contrast, odonate larvae and *Sialis* were more common in lowland and some impacted sites (Table 10).

The twelve taxa listed above were scored (as described in methods) based on 99% confidence limits on the mean absolute value for upland sites and summed (Table 11). The summed score averaged 32.5 for upland streams, 29.5 for lowland streams, and 27 for impacted streams. The summed scores were regressed against the refined habitat assessment scores and showed a positive relationship (r^2=0.25)(Fig. 16). The results suggest much variation in the presence and absence of particular taxa within and among stream types. The taxa score was summed with

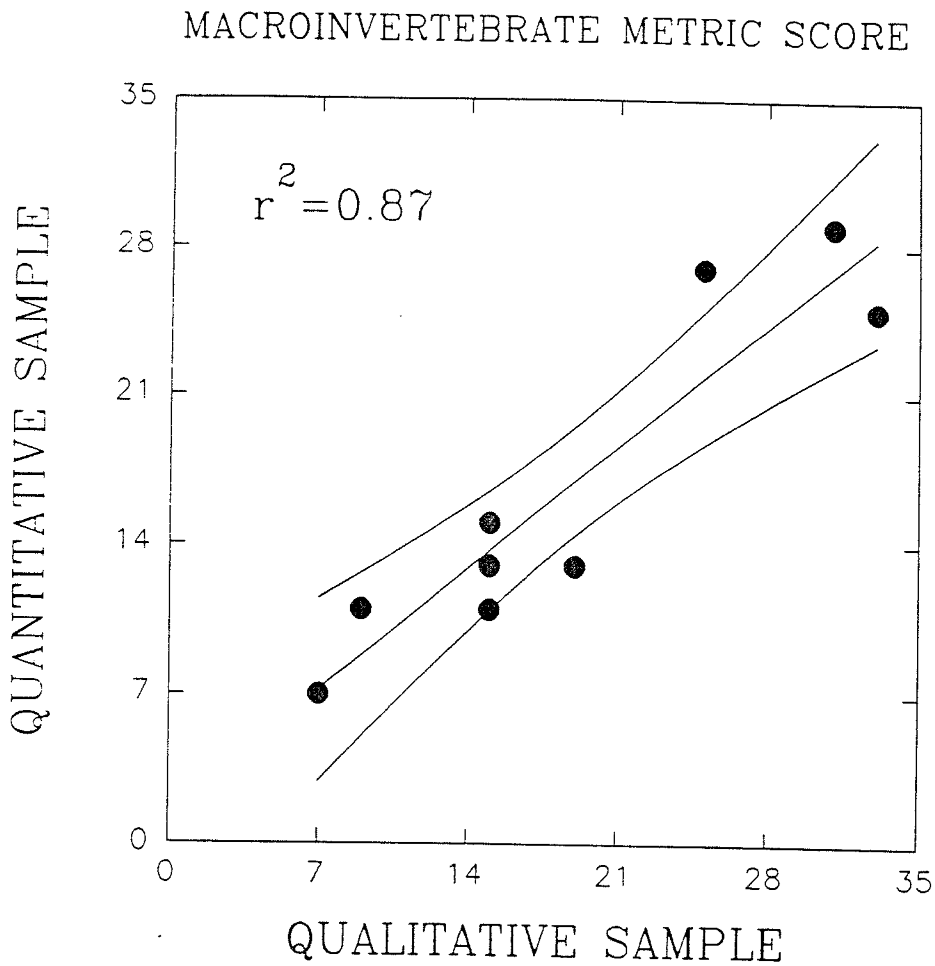


Fig. 12. Regression of macroinvertebrate metric score determined from qualitative sample versus score determined from quantitative samples. Regression line bounded by 95% CL.

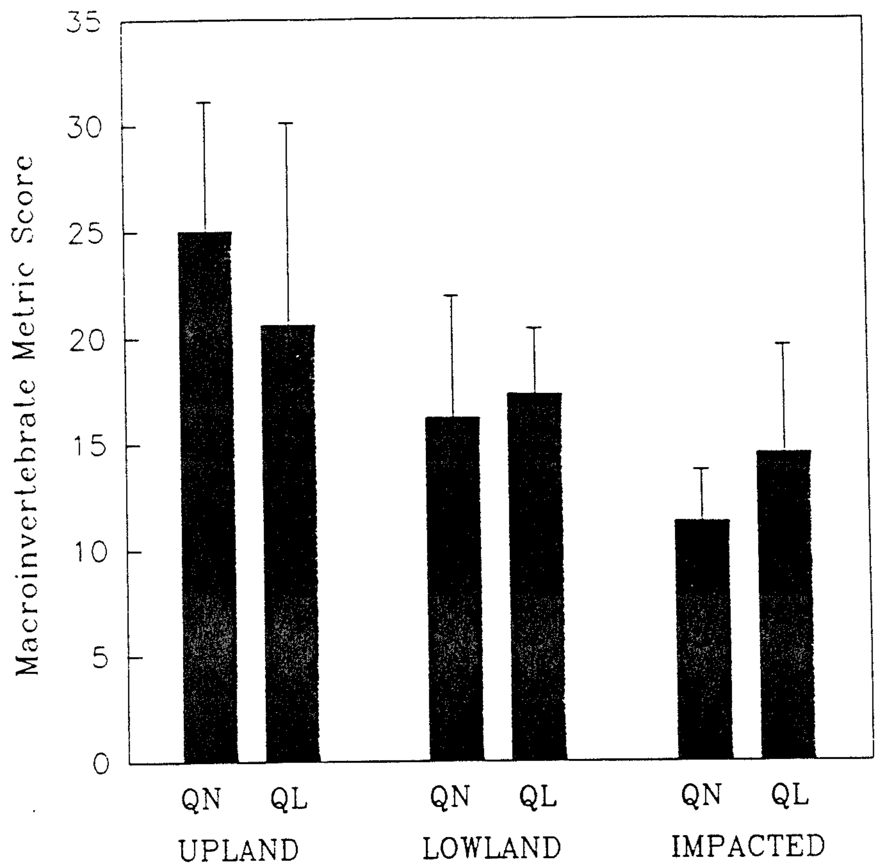


Fig. 13. Mean macroinvertebrate metric scores for both Quanitative (QN) and Qualitative (QL) measurements for each site type. Vertical bars represent one standard deviation from the mean.

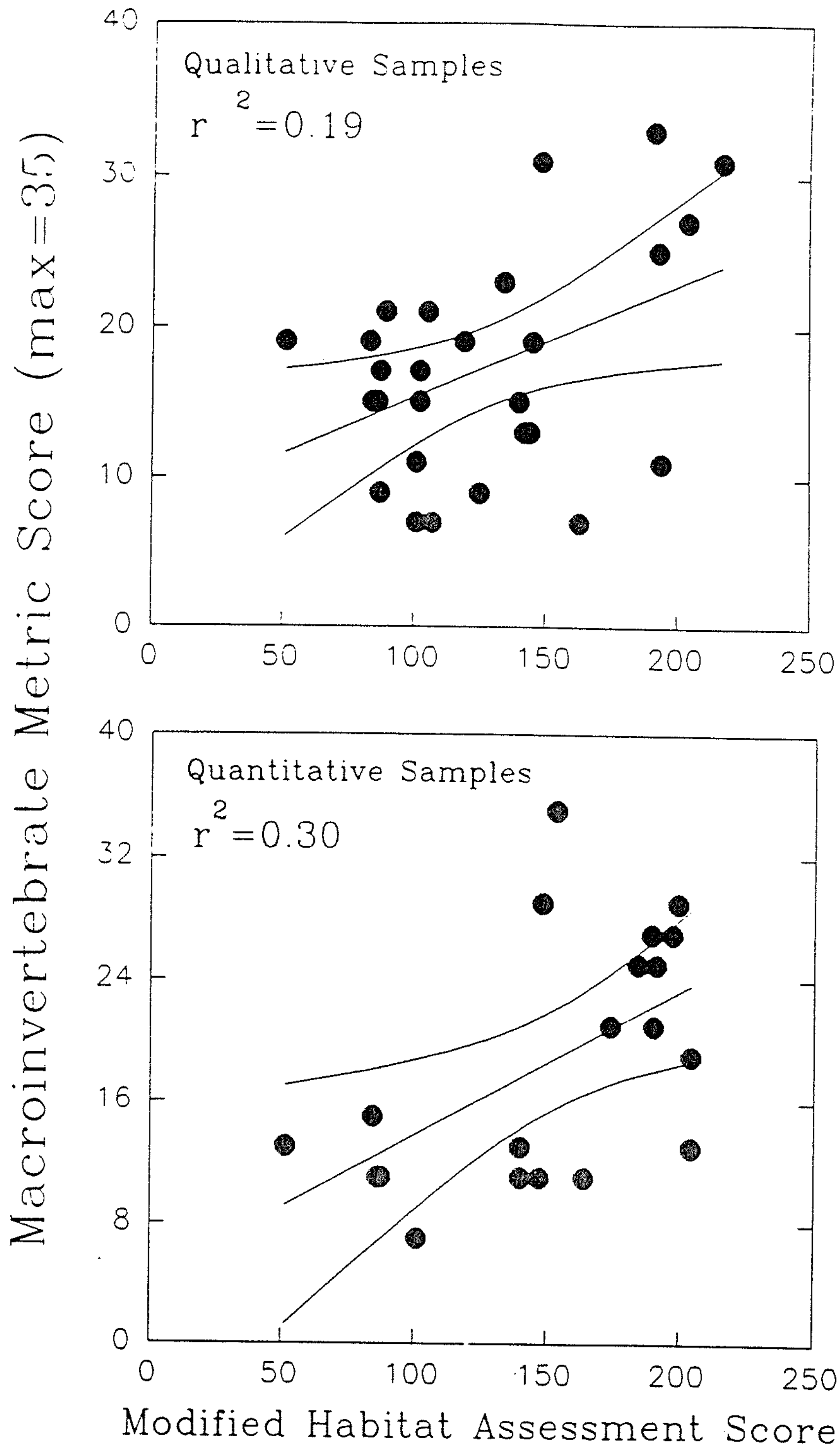


Fig. 14. Macroinvertebrate metric scores regressed against the modified habitat assessment score for qualitative and qualtitative samples from both ecoregions.

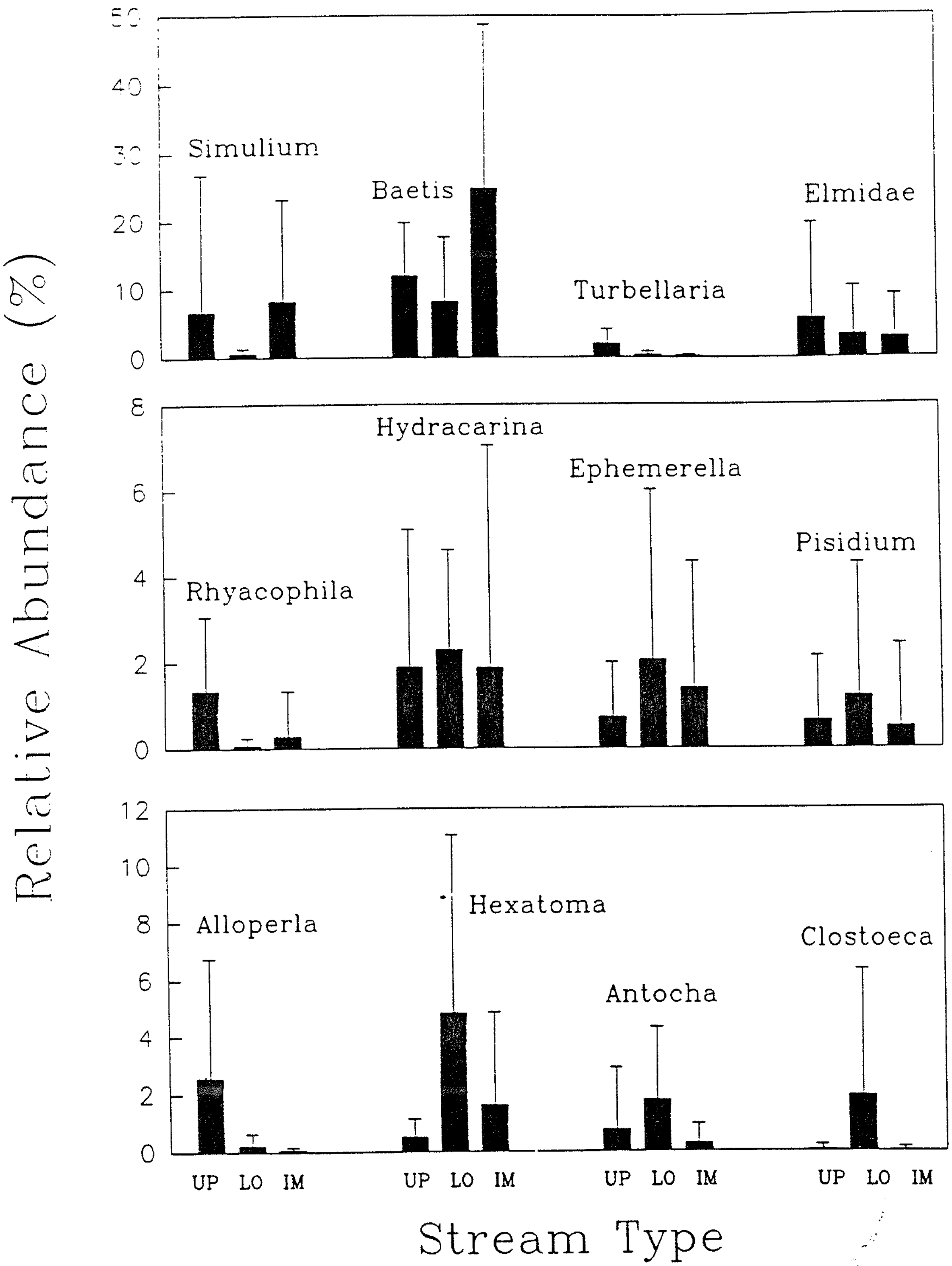


Fig. 15. Mean relative abundances of the twelve most common macroinvertebrates collected in upland (UP), lowland (LO), and impacted (IM) stream sites. Vertical bars represent one standard deviation from the mean.

Table 10. Macroinvertebrate taxa that comprised >5% of the assemblage for any one site. See Appendix F for taxa names for respective species notations.

TYPE	SITE	REP #	cinyg	simu	epeo	chir	baet	drco	turb	elmi	seti	drdo	rhac	cali	capn	micr	brac	olig	pael	rhit	hydra	glos	rhya	zapa	arct
1	1	QUAL.	20.00	13.90	11.86	8.47	7.46	6.78	4.75	4.41	3.05	2.03	2.03	1.69	1.36	1.02	1.02	1.02	1.02	1.02	1.02	1.02	0.68	0.34	0.34
1	2	QUAL.		91.96	1.60	1.29	0.96			1.93							0.32							0.32	
1	3	QUAL.		1.35	1.35	1.01	18.92			56.08				0.68		1.01	2.70	0.34			1.35				
1	4	QUAL.		5.78	21.30	6.50	20.58			32.85						1.08	0.36				0.36		0.36		
1	5	QUAL.	7.02	0.35	2.81	36.49	14.04		1.40	11.58		2.11				4.21	1.40						0.35	0.70	0.70
1	8	QUAL.				17.22	3.66											2.56				4.03	0.73	1.10	
1	37	QUAL.	2.09	0.42	7.95	16.32	13.39	7.11	1.26		0.42	0.84	6.69		0.42	5.86		3.35	0.42		0.84			14.23	
1	39	QUAL.	6.25	0.74	31.62	0.37	21.69	2.21				2.94	1.47	1.10			0.37	4.04		0.74			1.10	0.37	1.84
1	40	QUAL.	14.23	4.49	9.36	5.99	11.99	3.00	0.75		0.75	9.36	1.12	4.12		1.12		10.11	3.37		0.37		4.12	7.49	
1	43	QUAL.	8.68	2.78		23.26	27.08	1.74	2.08		2.08	0.35	1.39		0.69	0.35		3.47	4.17		3.47		1.74	3.47	
1	35	QUAN.	25.79	0.63		4.72	23.90		6.92				0.63					0.94			1.26		0.63	2.20	
1	36	QUAN.	25.53	0.91	7.29	3.34	18.54	6.69	3.34		0.61	3.34	1.22				2.13	3.65			0.91		1.82	1.52	
1	37	QUAN.	15.42		3.33	9.17	2.92	0.42	2.92		0.42	1.25	3.75		0.42	0.83		2.92		0.83	4.58		0.42	5.83	
1	38	QUAN.	12.01			6.31	11.11		2.40			0.60	4.20		12.91			13.21			14.41		4.20	1.80	
1	39	QUAN.	5.43		0.36	1.81	3.62	3.26				0.36						71.01		0.36	0.72		0.36		0.36
1	40	QUAN.	12.66		3.80	27.22	8.23		0.63		3.80	0.63	0.95	0.32			0.32	16.14	1.58		1.27	0.32	0.95	5.06	
1	41	QUAN.	1.67		6.02	17.39	1.34	0.33	2.34			8.03	1.34	2.68	2.01			25.42	9.36	3.34	3.01		5.35	5.02	
1	42	QUAN.			3.92		12.16	1.18	6.67			2.75	0.39		1.18			49.41	1.18	2.75			4.31	1.57	
1	43	QUAN.	16.89	1.01	2.03	31.76	4.73	0.34	0.68		8.45				0.34	0.34		8.11	1.69		2.36		5.07	2.70	
2	15	QUAL.			1.15	21.76				24.43				1.91				3.44			1.53	8.02		9.54	
2	16	QUAL.			1.38	38.97	0.69										1.38	3.45			3.45	0.34			
2	17	QUAL.	0.31	0.62	2.17	28.88	20.19						0.62	1.24				3.42			0.31	4.66		12.73	
2	18	QUAL.		1.73	0.29	16.47	3.47		0.58	8.96							14.74	1.73			4.34				
2	19	QUAL.		2.56		1.92	28.53			1.60							1.60	9.62			5.77				
2	48	QUAL.	2.88			35.78		0.32						3.51							2.56				
2	44	QUAN.				15.18	9.49		1.90					4.61	0.54			2.71		1.36					
2	45	QUAN.			0.78	21.40	2.73	0.39	0.39					1.95			5.45	12.84				3.89			
2	46	QUAN.		0.35	3.52	22.18	17.25				0.35						4.58				6.69		2.82		
2	47	QUAN.				69.27												8.85							
2	48	QUAN.			4.42	39.53								3.54				11.80			0.59				
3	26	QUAL.		47.72	1.05	27.72	5.26											1.05			0.70				
3	27	QUAL.			11.19	20.28	2.10											2.45			0.35	2.10			
3	28	QUAL.		1.54	0.38	32.31	6.15			23.08							3.85	5.00			4.62	0.38	6.92		
3	29	QUAL.				37.67	14.73			2.05								9.93			0.34			0.34	12.67
3	30	QUAL.	1.81			13.72	2.53		0.72	2.17								1.08			22.74			1.81	
3	31	QUAL.		1.44	0.36	5.05	28.16			15.88							21.66	1.08							
3	32	QUAL.		2.12	1.06	11.31	12.01		0.35	7.42								4.95			2.12				
3	49	QUAL.	4.97	2.32		7.62	63.25						4.64					4.64							
3	50	QUAL.	0.55	1.37	3.01	24.86	41.53		0.27		0.82						1.64	3.01			0.55				
3	51	QUAL.	0.67	2.67		4.00											2.00	14.67			0.33				
3	52	QUAL.	5.23	0.92		6.77	64.00														0.62		0.31		
3	53	QUAL.		45.22			23.57											1.91	2.55			0.32		5.41	
3	49	QUAN.	4.60	0.92	0.23	28.51	18.85											40.23							
3	50	QUAN.		0.94		2.19	68.65				1.57		0.31				4.08	0.31			0.63		0.63		
3	51	QUAN.		7.52		14.76	0.56										0.56	27.86							
3	52	QUAN.	6.60	1.39		21.18	51.74	0.35	0.69								0.35	2.08			0.35				
3	53	QUAN.		29.92			44.60											3.88	0.83		0.28	0.83		8.03	
3	54	QUAN.		0.20		2.87	0.10										1.95								
upland		mean	9.14	6.54	6.03	11.51	11.91	1.74	1.90	5.62	1.03	1.82	1.33	0.56	1.02	0.83	0.45	11.35	1.20	0.48	1.89	0.28	1.69	2.83	0.17
		std	8.46	20.39	7.95	10.97	7.88	2.44	2.13	14.11	2.06	2.60	1.74	1.10	2.86	1.53	0.77	18.29	2.26	0.94	3.21	0.91	1.83	3.45	0.43
lowland		mean	0.32	0.48	1.25	28.30	8.12	0.06	0.26	3.18	0.03	0.00	0.06	1.52	0.05	0.00	2.52	5.26	0.00	0.12	2.29	1.54	0.26	2.02	0.00
		std	0.86	0.83	1.46	16.82	9.49	0.14	0.55	7.19	0.10	0.00	0.18	1.64	0.16	0.00	4.29	4.44	0.00	0.39	2.34	2.61	.81	4.35	0.00
impacted		mean	1.36	8.12	0.96	14.49	24.88	0.02	0.11	2.81	0.13	0.00	0.27	0.00	0.00	0.00	2.00	6.90	0.19	0.00	1.87	0.20	0.44	0.87	0.70
		std	2.21	15.12	2.58	11.63	23.81	0.08	0.23	6.27	0.40	0.00	1.06	0.00	0.00	0.00	4.94	10.45	0.60	0.00	5.18	0.51	1.58	2.16	2.90

Table 10. (cont.)

TYPE	SITE	REP #	hete	amel	hydro	ephe	pisi	gren	allo	hexa	para	cera	hyal	tric	amph	anto	hdrop	ostr	clos	opti	sial	ptca	ophi	font
1	1	QUAL.	0.34	0.34																				
1	2	QUAL.				0.96			0.32				0.32											
1	3	QUAL.				4.05	0.68	1.01					2.70			0.68		2.03				1.35		
1	4	QUAL.			0.72		0.36																	
1	5	QUAL.			7.37	4.21	1.40	1.40	0.35															
1	8	QUAL.	44.69		12.45		5.86				0.37	0.37		0.73		2.93						2.56		
1	37	QUAL.	7.95	0.42							4.18					0.42			0.84	0.84		0.42		
1	39	QUAL.	0.74			1.10			17.28	1.10														
1	40	QUAL.							4.49	1.87														
1	43	QUAL.	2.08	0.69		2.08			2.78	1.39														
1	35	QUAN.	15.72							0.31					0.75	0.63								
1	36	QUAN.	1.82		1.52					0.30					0.61	9.42								
1	37	QUAN.	28.33	1.25			3.75		0.83		2.08									5.00				
1	38	QUAN.	0.30	1.80					3.30	0.60														
1	39	QUAN.	0.36						3.62	0.36		2.90	0.36	0.36										
1	40	QUAN.	1.90	0.95					9.81	0.95														
1	41	QUAN.	0.33	0.33		0.33			1.00	2.01	0.67													
1	42	QUAN.	1.57			0.78			2.35															
1	43	QUAN.	2.36	1.01					2.36	0.68		0.34												
2	15	QUAL.			3.05			9.16			2.67			1.91		6.11	0.38	3.44			0.38			
2	16	QUAL.			1.38		0.34	1.72		2.07				6.55		1.72				21.38	2.41		3.79	
2	17	QUAL.			1.24		0.62		1.24			0.31					2.17			12.42	0.93			
2	18	QUAL.				11.85	1.45		0.29	6.07			18.50			0.58		6.36						
2	19	QUAL.				8.65	10.90		0.96	7.37			5.77			0.96		10.26						
2	48	QUAL.	7.67	0.96	0.96					0.32	1.28	0.64		22.36					15.34		1.60			
2	44	QUAN.	43.36		3.52					1.90	1.36			0.27		7.59							0.27	
2	45	QUAN.	5.06			1.95				18.29	3.50								1.17					
2	46	QUAN.			0.35					15.85	0.35	0.35				2.46			0.35	13.03				
2	47	QUAN.		2.86						0.52		4.43									13.28			
2	48	QUAN.	8.85	2.95	2.95					0.59	4.42	0.29		8.26					4.42		1.18			
3	26	QUAL.	1.75		0.35							2.46		0.70			2.11						1.05	
3	27	QUAL.			20.63					1.75	4.90			8.39	1.05	1.40				12.24	2.80		1.75	
3	28	QUAL.			6.15	6.15						0.77												
3	29	QUAL.											3.42	3.77			4.45						0.34	
3	30	QUAL.									15.16						23.10	11.55						
3	31	QUAL.			0.72	2.53								0.36				1.08				6.50	10.11	
3	32	QUAL.			10.95	11.66	8.48						2.12	3.18				0.71						
3	49	QUAL.		0.33							0.66		0.66							1.99		0.66		
3	50	QUAL.	4.92		8.20					5.46						2.46			0.55					
3	51	QUAL.		26.67						0.33			0.67	47.00										
3	52	QUAL.				1.85				12.62		0.62					0.92			1.54			1.23	
3	53	QUAL.		0.32					0.32											19.75		0.32		
3	49	QUAN.	4.83																	0.23				
3	50	QUAN.	0.31		8.46					2.82														
3	51	QUAN.		14.48										30.36				3.34		0.28				
3	52	QUAN.	1.39			2.78			0.35	5.90	0.69					1.39								
3	53	QUAN.							0.28	0.28		0.28								8.31				
3	54	QUAN.			0.92		0.31						0.20							0.10				89.75
upland		mean	5.71	0.36	1.16	0.71	0.63	0.13	2.55	0.50	0.38	0.19	0.18	0.06	0.55	0.74	0.00	0.11	0.04	0.31	0.00	0.23	0.00	0.00
		std	11.50	0.52	3.13	1.29	1.51	0.38	4.20	0.64	1.02	0.65	0.60	0.18	2.17	2.15	0.00	0.45	0.19	1.12	0.00	0.63	0.00	0.00
lowland		mean	5.90	0.62	1.22	2.04	1.21	0.99	0.23	4.82	1.23	0.55	2.21	3.58	0.00	1.77	0.23	1.82	1.93	4.26	1.80	0.00	0.37	0.00
		std	12.28	1.11	1.30	3.97	3.09	2.63	0.42	6.25	1.53	1.24	5.41	6.57	0.00	2.54	0.62	3.31	4.42	7.27	3.71	0.00	1.09	0.00
impacted		mean	0.73	2.32	3.13	1.39	0.49	0.00	0.05	1.62	1.19	0.23	0.39	5.21	0.06	0.29	1.70	0.93	0.03	2.47	0.16	0.42	0.80	4.99
		std	1.54	6.77	5.51	2.95	1.94	0.00	0.12	3.23	3.57	0.58	0.89	12.33	0.24	0.68	5.31	2.70	0.13	5.30	0.64	1.48	2.31	20.56

Table 11. Absolute values and respective scores for important macroinvertebrate taxa for metric refinement. Species names associated with respective notations found in Appendix F.

TYPE	SITE	REP #	simu	SCR	baet	SCR	turb	SCR	elmi	SCR	rhac	SCR	hydra	SCR	ephe	SCR	pisi	SCR	allo	SCR	hexa	SCR	anto	SCR	TOTAL SCORE
1	1	QUAL.	13.90	3	7.46	5	4.75	5	4.41	1	2.03	5	1.02	3		5		5		1		5		1	39
1	2	QUAL.	91.96	1	0.96	5		1	1.93	1		1		1	0.96	3		5	0.32	1		5		1	25
1	3	QUAL.	1.35	5	18.92	1		1	56.08	5		1	1.35	3	4.05	1	0.68	3		1		5	0.68	1	27
1	4	QUAL.	5.78	5	20.58	1		1	32.85	5		1	0.36	1		5	0.36	5		1		5		1	31
1	5	QUAL.	0.35	5	14.04	3	1.40	1	11.58	5		1		1	4.21	1	1.40	1	0.35	1		5		1	25
1	8	QUAL.		5	3.66	5		1		1		1		1		5	5.86	1		1		5	2.93	5	31
1	37	QUAL.	0.42	5	13.39	3	1.26	1		1	6.69	5	0.84	1		5		5		1		5	0.42	1	33
1	39	QUAL.	0.74	5	21.69	1		1		1	1.47	3		1	1.10	1		5	17.28	5	1.10	1		1	25
1	40	QUAL.	4.49	5	11.99	5	0.75	1		1	1.12	3	0.37	1		5		5	4.49	5	1.87	1		1	33
1	43	QUAL.	2.78	5	27.08	1	2.08	3		1	1.39	3	3.47	5	2.08	1		5	2.78	3	1.39	1		1	29
1	35	QUAN.	0.63	5	23.90	1	6.92	5		1	0.63	1	1.26	3		5		5		1	0.31	5	0.63	1	33
1	36	QUAN.	0.91	5	18.54	1	3.34	5		1	1.22	3	0.91	1		5		5		1	0.30	5	9.42	5	37
1	37	QUAN.		5	2.92	5	2.92	3		1	3.75	5	4.58	5		5	3.75	1	0.83	1		5		1	37
1	38	QUAN.		5	11.11	5	2.40	3		1	4.20	5	14.41	5		5		5	3.30	3	0.60	3		1	41
1	39	QUAN.		5	3.62	5		1		1		1	0.72	1		5		5	3.62	3	0.36	5		1	33
1	40	QUAN.		5	8.23	5	0.63	1		1	0.95	1	1.27	3		5		5	9.81	5	0.95	3		1	35
1	41	QUAN.		5	1.34	5	2.34	3		1	1.34	3	3.01	5	0.33	5		5	1.00	1	2.01	1		1	35
1	42	QUAN.		5	12.16	3	6.67	5		1	0.39	1		1	0.78	3		5	2.35	1		5		1	33
1	43	QUAN.	1.01	5	4.73	5	0.68	1		1		1	2.36	5		5		5	2.36	1	0.68	3		1	35
2	15	QUAL.		5		5		1	24.43	5		1	1.53	3		5		5		1		5	6.11	5	41
2	16	QUAL.		5	0.69	5		1		1		1	3.45	5		5	0.34	5		1	2.07	1	1.72	5	35
2	17	QUAL.	0.62	5	20.19	1		1		1	0.62	1	0.31	1		5	0.62	3	1.24	1		5		1	25
2	18	QUAL.	1.73	5	3.47	5	0.58	1	8.96	3		1	4.34	5	11.85	1	1.45	1	0.29	1	6.07	1	0.58	1	25
2	19	QUAL.	2.56	5	28.53	1		1	1.60	1		1	5.77	5	8.65	1	10.90	1	0.96	1	7.37	1	0.96	3	21
2	48	QUAL.		5		5		1		1		1	2.56	5		5		5		1	0.32	5		1	35
2	44	QUAN.		5	9.49	5	1.90	1		1		1		1		5		5		1	1.90	1	7.59	5	31
2	45	QUAN.		5	9.73	5	0.39	1		1		1		1	1.95	1		5		1	18.29	1		1	23
2	46	QUAN.	0.35	5	17.25	1		1		1		1	6.69	5		5		5		1	15.85	1	2.46	5	31
2	47	QUAN.		5		5		1		1		1		1		5		5		1	0.52	3		1	29
2	48	QUAN.		5		5		1		1		1	0.59	1		5		5		1	0.59	3		1	29
3	26	QUAL.	47.72	1	5.26	5		1		1		1	0.70	1		5		5		1		5		1	27
3	27	QUAL.		5	2.10	5		1		1		1	0.35	1		5		5		1	1.75	1	1.40	3	29
3	28	QUAL.	1.54	5	6.15	5		1	23.08	5		1	4.62	5	6.15	1		5		1		5		1	35
3	29	QUAL.		5	14.73	3		1	2.05	1		1	0.34	1		5		5		1		5		1	29
3	31	QUAL.	1.44	5	28.16	1		1	15.88	5		1		1	2.53	1		5		1		5		1	27
3	32	QUAL.	2.12	5	12.01	3	0.35	1	7.42	3		1	2.12	5	11.66	1	8.48	1		1		5		1	27
3	49	QUAL.	2.32	5	63.25	1		1		1	4.64	5		1		5		5		1		5		1	31
3	50	QUAL.	1.37	5	41.53	1	0.27	1		1		1	0.55	1		5		5		1	5.46	1	2.46	5	27
3	51	QUAL.	2.67	5		5		1		1		1	0.33	1		5		5		1	0.33	5		1	31
3	52	QUAL.	0.92	5	64.00	1		1		1		1	0.62	1	1.85	1		5		1	12.62	1		1	19
3	53	QUAL.	45.22	1	23.57	1		1		1		1		1		5		5	0.32	1		5		1	23
3	49	QUAN.	0.92	5	18.85	1		1		1		1		1		5		5		1		5		1	27
3	50	QUAN.	0.94	5	68.65	1		1		1	0.31	1	0.63	1		5		5		1	2.82	1		1	23
3	51	QUAN.	7.52	3	0.56	5		1		1		1		1		5		5		1		5		1	29
3	52	QUAN.	1.39	5	51.74	1	0.69	1		1		1	0.35	1	2.78	1		5	0.35	1	5.90	1	1.39	3	21
3	53	QUAN.	29.92	1	44.60	1		1		1		1	0.28	1		5		5	0.28	1	0.28	5		1	23
3	54	QUAN.	0.20	5	0.10	5		1		1		1		1		5	0.31	5		1		5		1	31
upland		mean	6.54		11.91		1.90		5.62		1.33		1.89		0.71		0.63		2.55		0.50		0.74		
		99CL	8.321		3.215		0.87		5.756		0.709		1.31		0.527		0.616		1.716		0.263		0.878		
SCORE		5	<6		<12		>3		>11		>2		>2		<.5		<.5		>4		<.5		>1.5		
		3	6-15		12-15		2-3		6-11		1-2		1-2		.5-1		.5-1		2.5-4		.5-1		.7-1.5		
		1	>15		>15		<2		<6		<1		<1		>1		>1		<2.5		>1		<.7		

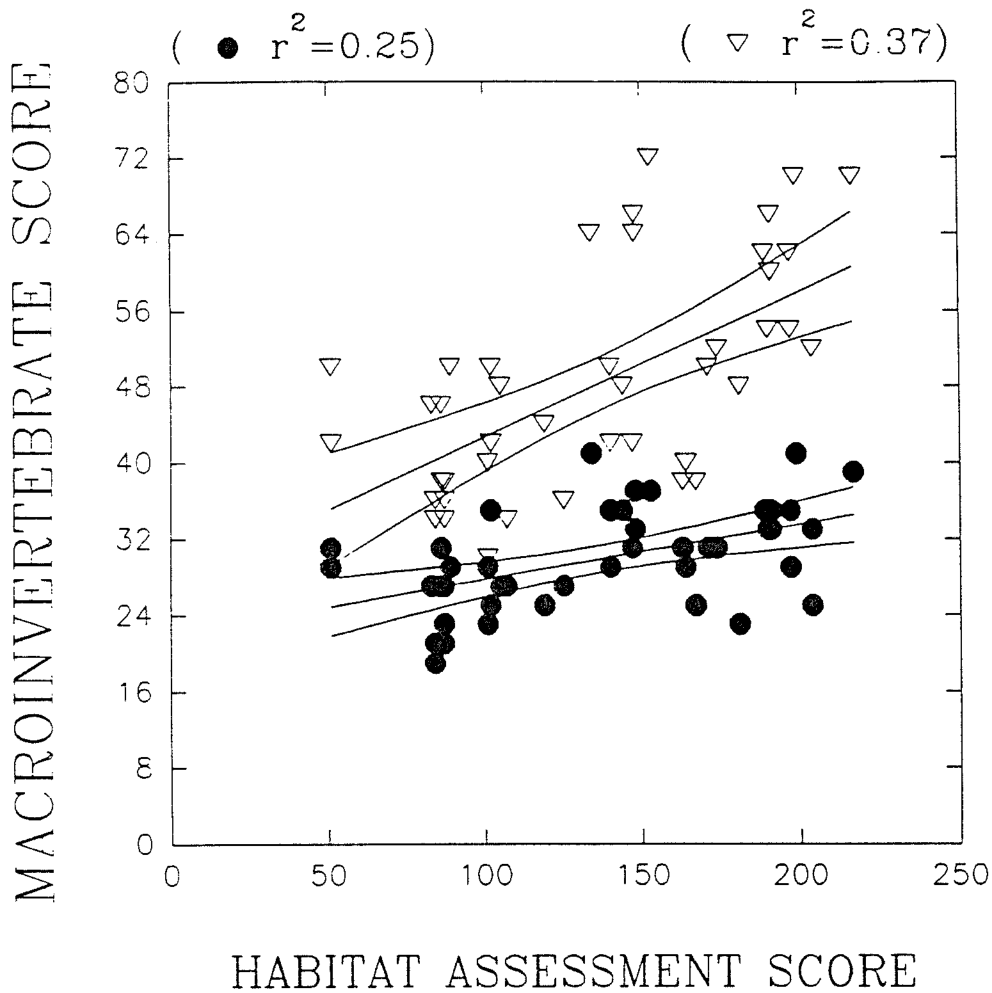


Fig. 16. Regression of the macroinvertebrate species score (●) and the combined species and refined metric score (▽) against the refined habitat assessment score. Regression lines bounded by 95% CL.

the refined macroinvertebrate metric score and regressed against the habitat assessment score. This relationship also was found to be positive ($r^2=0.37$); this value was identical to the regression coefficient of the refined metric score and habitat score. These data suggest further refinement is necessary for taxa level metric development.

Fish Metric Development: Table 8 provides the raw data for fish species collected from each site, and designations of fish taxa for tolerance, trophic guild, and whether native or introduced (Chandler and Maret 1991). Evident from this table is the shift from a relatively intolerant Salmonidae-based system in upland streams to a tolerant non-Salmonidae based system in impacted streams. This data is summarized in Table 8 for the 20 individual metrics. Principal Components Analysis and Multiple Discriminant Analysis agreed closely with important fish metrics to distinguish among stream types and ecoregions. Six of the original 20 metrics were found important: Number of Salmonidae Taxa, Number of Tolerant Taxa, % Salmonidae, Salmonidae Biomass, Tolerant Density, and Salmonidae Condition Factor (Table 12). A score of five indicated optimal conditions for a particular metric, with a maximum summed fish metric score equal to 30.

Salmonidae were predominant in upland sites, whereas tolerant taxa were predominant in impacted streams (Fig. 17). Salmonidae species richness, % Salmonidae, Salmonidae standing crops, and the condition factor of Salmonidae were highest in upland streams, followed by lowland, and then impacted sites. In contrast, the number of tolerant taxa and density of tolerant fish were highest in lowland and impacted streams than in upland streams (Fig. 17). Salmonidae species richness, % Salmonidae, Salmonidae biomass, and Salmonidae condition also appeared to be greater in the Northern Basin and Range ecoregion than in the Snake River Plain ecoregion. In addition, the number of tolerant taxa and tolerant fish density appeared greater in the Snake

Table 12. Metrics and corresponding scores derived from fish collections in the Snake River Plain and Northern Basin and Range Ecoregions.

STREAM	TYPE	NUMBER SALMON SPECIES	SC	NUMBER TOLERANT SPECIES	SC	% SALMON	SC	SALMON BIOM	SC	TOLERANT DENSITY	SC	CONDITION FACTOR	SC	TOTAL SCORE MAX=30
Green	Up	2	5	0	5	1	5	1.93	5	0	5	1.08	5	30
Stinson	Up	1	5	0	5	1	5	8.54	5	0	5	1.07	5	30
Trapper (upper)	Up	1	5	0	5	0.5	3	1.07	1	0	5	1	5	24
Buck	Up	1	5	0	5	1	5	1.67	1	0	5	0.88	5	26
Cottonwood	Up	3	5	0	5	0.75	5	2.66	5	0	5	0.97	5	30
3rd Fork	Up	1	5	0	5	1	5	7.02	5	0	5	0.97	5	30
Bloomington	Up	1	5	0	5	1	5	0.18	1	0	5	1.36	5	26
Mink (Preston)	Up	1	5	0	5	1	5	5.69	5	0	5	1.16	5	30
WF Mink (Poc.)	Up	1	5	0	5	1	5	1.95	5	0	5	1.06	5	30
Timber	Up	1	5	0	5	1	5	3.85	5	0	5	1.13	5	30
SF Soldier	Up	1	5	0	5	0.5	3	0.4	1	0	5	1.32	5	24
Cherry	Up	0	1	0	5	0	1	0	1	0	5	NA	1	14
Bear	Up	1	5	0	5	1	5	0.82	1	0	5	1.07	5	26
Ramey	Up	1	5	0	5	1	5	1.51	1	0	5	1.29	5	26
Coyote	Up	1	5	0	5	0.5	3	0.07	1	0	5	1.12	5	24
Rock (Twin S-8)	Up	2	5	1	1	0.66	5	1.04	1	0.023	5	0.874	5	22
Little Jack's	Lo	1	5	0	5	0.5	3	0.66	1	0	5	0.73	1	20
Big Jack's (upper)	Lo	1	5	3	1	0.25	1	0.37	1	0.993	1	0.86	5	14
Cottonwood	Lo	1	5	0	5	1	5	4.75	5	0	5	0.86	5	30
Lake Fork	Lo	1	5	1	1	0.33	1	0.46	1	0.076	5	0.85	5	18
Station Fork	Lo	2	5	0	5	0.5	3	2.32	5	0	5	0.95	5	28
Big Willow	Lo	1	5	3	1	0.25	1	2.54	5	0.148	1	1.02	5	18
Cold Springs	Lo	1	5	1	1	0.5	3	2.96	5	0.033	5	0.92	5	24
Current	Up	0	1	1	1	0	1	0	1	0.006	5	NA	1	10
Duncan (upper)	Lo	1	5	0	5	1	5	8.57	5	0	5	1.29	5	30
Spring	Lo	1	5	3	1	0.25	1	2.67	5	2.186	1	1.07	5	18
Sheep	Im	0	1	2	1	0	1	0	1	0.192	1	NA	1	6
Big Jack's (lower)	Im	1	5	3	1	0.25	1	1.06	1	0.269	1	0.78	3	12
Cassia	Im	1	5	2	1	0.25	1	0.72	1	0	5	1.02	5	18
Mary's	Im	0	1	2	1	0	1	0	1	0.118	3	NA	1	8
Duncan (lower)	Im	1	5	0	5	1	5	5.05	5	0	5	0.81	3	28
Trapper (lower)	Im	1	5	1	1	0.5	3	1.98	5	0.02	5	1.05	5	24
Shoshone	Im	0	1	5	1	0	1	0	1	0.273	1	NA	1	6
SF Mink (Poc.)	Im	0	1	0	5	0	1	0	1	0	5	NA	1	14
Wolverine	Im	1	5	0	5	1	5	3.37	5	0	5	1.21	5	30
Camas	Im	0	1	3	1	0	1	0	1	0.098	5	NA	1	10
Deep	Im	1	5	3	1	0.2	1	0.05	1	0.276	1	1.14	5	14
Rock (Magic)	Im	1	5	0	5	0.5	3	0.05	1	0	5	0.81	3	22
Rock (Twin S-5)	Im	0	1	3	1	0	1	0	1	0.058	5	0.959	5	14
Rock (Twin S-6)	Im	1	5	1	1	0.5	3	0.08	1	0.012	5	1.06	5	20

	SCORE	NUMBER SALMON SPECIES	NUMBER TOLERANT SPECIES	% SALMON	SALMON BIOM	TOLERANT DENSITY	CONDITION FACTOR
GOOD	5	>.92	<.86	>.54	>1.88	<.110	>.84
FAIR	3	>.83	>.86	>.49	>1.71	>.110	>.76
POOR	1	<.83	>.94	<.49	<1.71	>.121	<.76

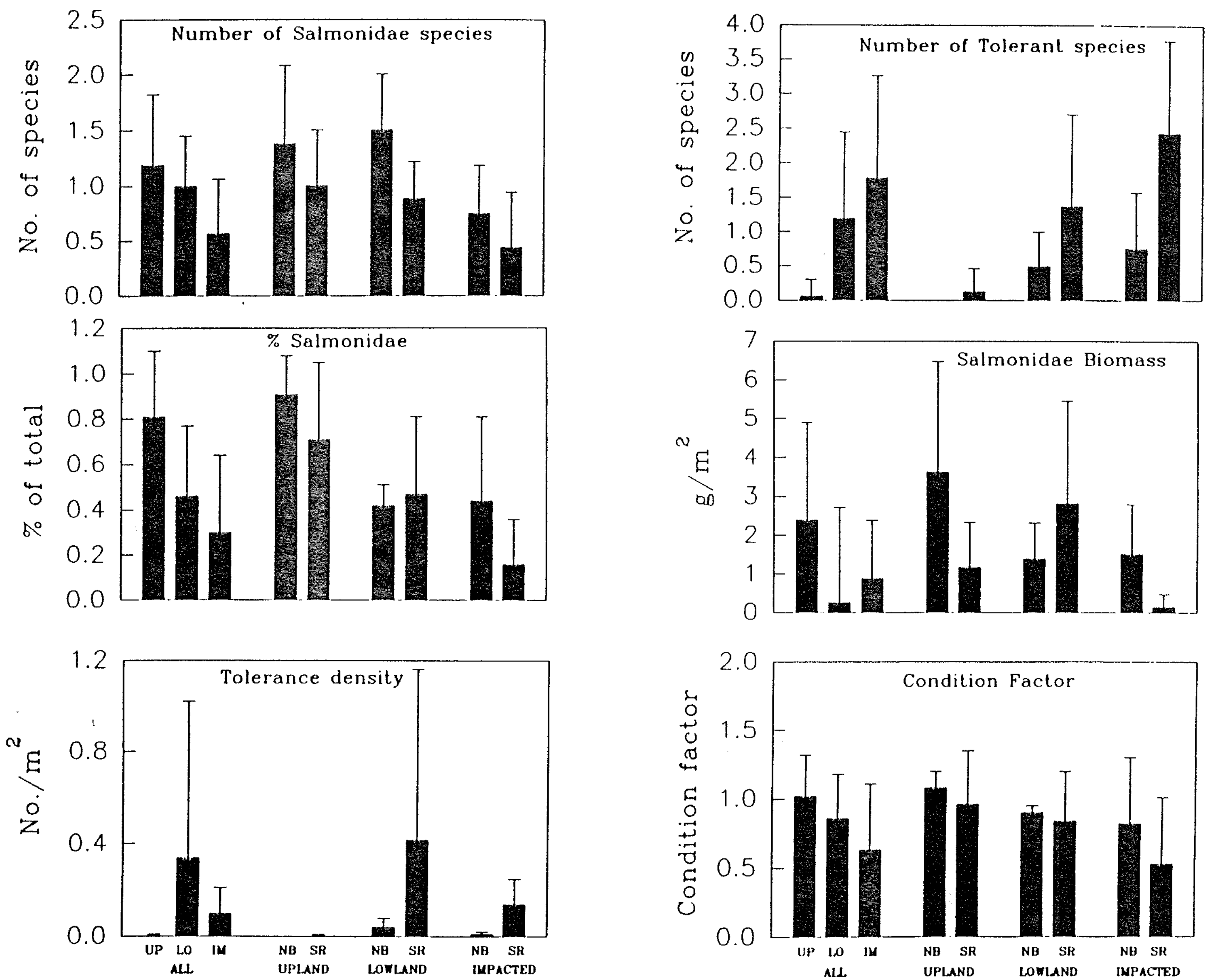


Fig. 17. Mean absolute values of fish metric scores for upland (UP), lowland (LO), and impacted (IM) sites combined and separate for Northern Basin and Range (NB) and Snake River Plain (SR) ecoregions (vertical bars = one standard deviation from mean).

River Plain ecoregion than in the Northern Basin and Range ecoregion (Fig. 17). These data suggest that streams in the Snake River Plain were more heavily impacted than streams in the Northern Basin and Range.

The fish metric score averaged 26.4 for upland, 21.0 for lowland, and 16.1 for impacted streams (Figure 18). Fish metric scores were comparable between the two ecoregions, although impacted streams of the SRP had lower values (mean=11.1) than impacted streams of the NBR (mean=18.7). The fish metric score showed a significant positive regression against the habitat assessment score (r^2=0.53)(Figure 19). Significant positive relationships were displayed when metric scores of both ecoregions were regressed independently against the habitat assessment score (NBR, r^2=0.66; SRP, r^2=0.61)(Figure 20). Further, both regression lines exhibited identical slopes, but the intercept for the SRP relationship was less than that for the NBR. This suggests that habitat quality is somwhat lower in the SRP than in the NBR, as was shown in average fish metric scores being lower in SRP impacted sites relative to NBR impacted sites (see Figure 18).

We regressed the number of fish captured using one-pass of the electrofisher against the estimated abundance based on three passes of the electrofisher. We found a positive relationship (r^2=0.66), although much variation was observed at higher fish densities (Fig. 21). These data suggest that three passes of the electrofisher should be completed in streams displaying higher fish densities. Apparently, low capture effectiveness occurs in streams with higher fish densities.

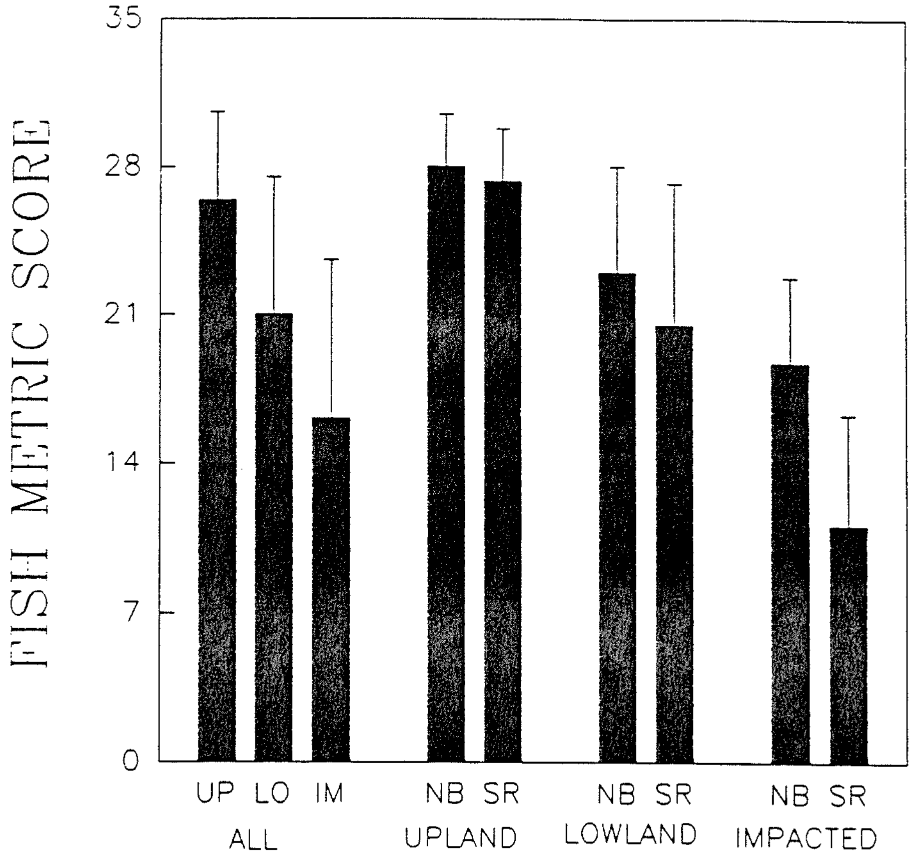


Fig. 18. Fish metric scores for upland (UP), lowland (LO), and impacted (IM) sites combined and separate for both Northern Basin and Range (NR) and Snake River Plain (SR) ecoregions. Vertical bars represent one standard deviation from the mean.

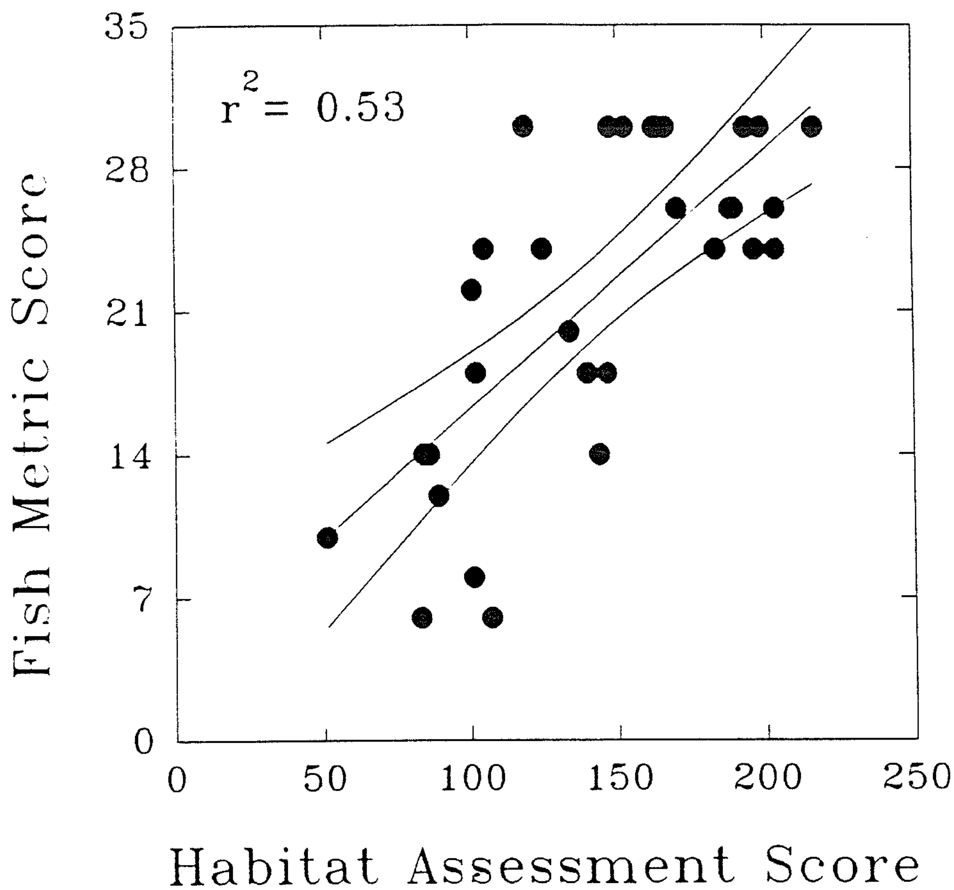


Fig. 19. Fish metric score regressed against the habitat assessment score. Outer diagonal lines represent 95% confidence limits.

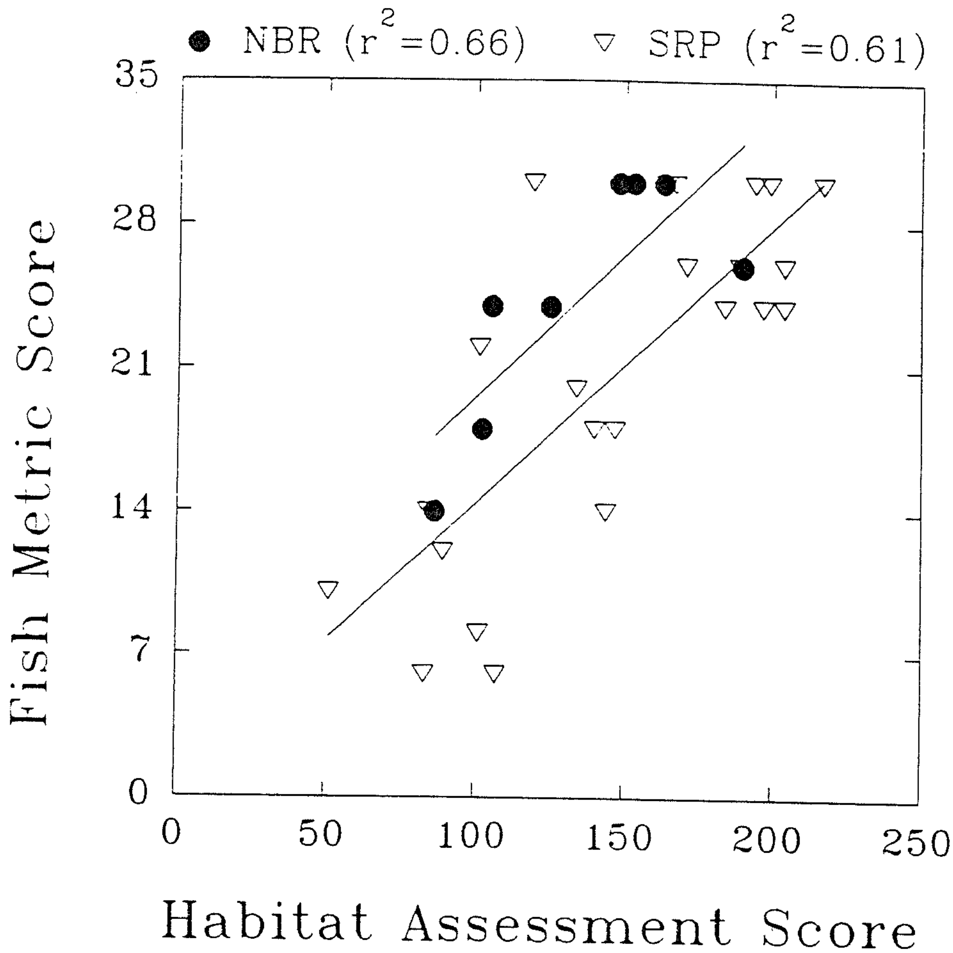


Fig. 20. Regression of Fish Metric Score on Habitat Assessment Score for Northern Basin and Range (NBR) and the Snake River Plain (SRP) ecoregions.

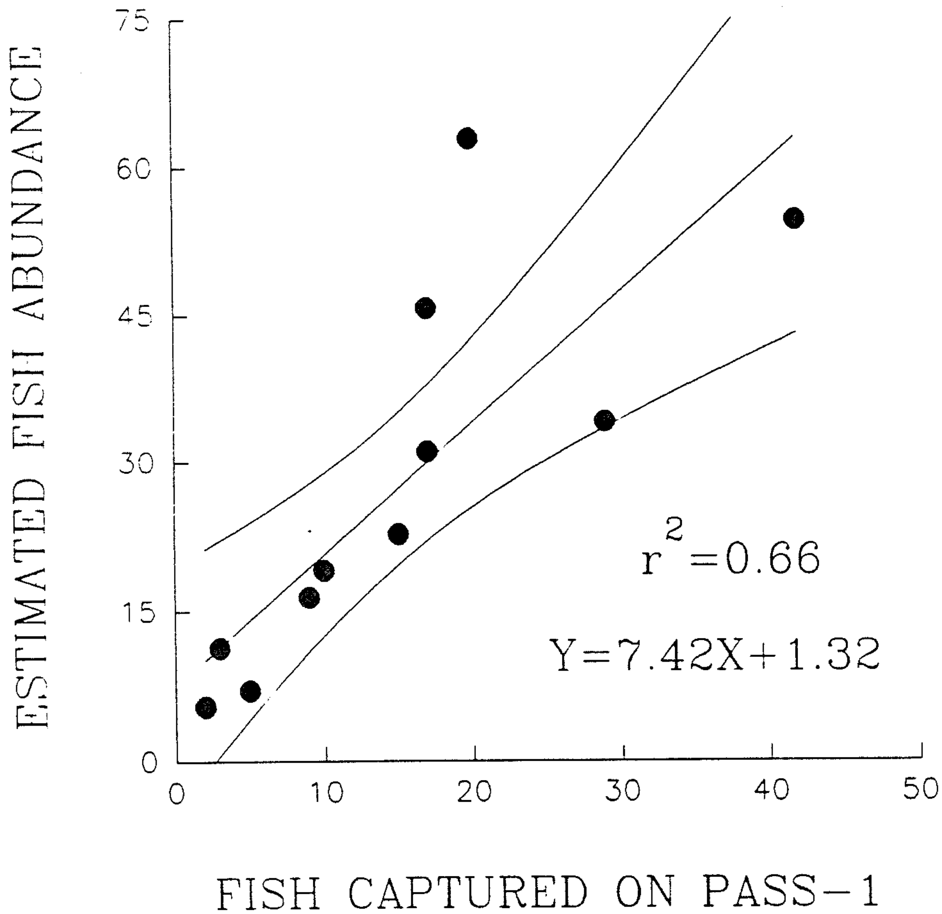


Fig. 21. Number of fish collected on the first electroshocking pass regressed on estimated fish abundance.

DISCUSSION

The primary goal of the project was to refine and test a series of biotic metrics for assessing biological integrity to eventually develop biological criteria for demonstrating recovery or degree of impact for freshwater ecosystems. The present study provided baseline monitoring data for macroinvertebrates and fish from a spectrum of "least" impacted or disturbed streams (i.e., upland and lowland stream types) in the two ecoregions. The use of rapid bioassessment protocols allowed for the efficient and effective collection of this reference data set. A standardized methodology proved effective for comparing and combining data from the previous year of study. For macroinvertebrates, we found a quantitative sample (modified Hess sampler, 250-μm mesh) to be as fast and provide additional information (e.g., organism density and biomass) and better resolution among stream types than a qualitative kick sample. The quantitative sampler also allowed for better sampling of specific habitat types. For fish, we found that a single pass of the electrofisher was effective in streams with low turbidity and low fish densities, but that a three-pass approach was needed when streams were turbid and/or had high fish densities. Blocknets were used with both the single-pass or three-pass approaches. The collection of baseline data from reference or "best case" streams should allow for the development of biological criteria for these two ecoregions for use by resource managers. However, additional samples providing a balanced sample size among stream types and ecoregions would greatly add to a robust analysis of the data. For example, Ohio EPA suggests a sample size of at least 40 streams per ecoregion (EPA 1990). Following their protocols, more samples are needed especially from the Nothern Basin and Range ecoregion and, in particular, for lowland type streams (currently n=2).

We found the addition of some quantitative variables for assessing aquatic habitats to be important or useful in distinguishing between ecoregions and among stream types. Based on results from Multiple Discriminant Analysis and Principal Components Analysis, measures of maximum water temperature, specific conductance, and nitrate and ortho-phosphate levels provided important additional information on differences in habitat conditions between ecoregions. Further, the inclusion of the measures suggested that aquatic habitats may be degraded more in the Snake River Plain than in the Northern Basin and Range ecoregion. However, it should be noted that only two lowland streams were sampled in the Northern Basin and Range. In addition to the above chemical measures, quantitative measures for specific physical parameters such as embeddedness, substrate size, width/depth ratio, and % canopy cover proved useful. For example, although sediment levels tended to be higher in lowland and impacted streams than in upland streams, nutrient levels were greatest in impacted sites. We suggest a compromise between the current qualitative approach and the addition of more quantitative measures. Little additional time was required for the collection and recording of these important habitat measures.

Seven macroinvertebrate metrics (EPT richness, H' diversity, %EPT, HBI, Simpson's Index, % dominance, and % Filterers) were found important for distinguishing among stream types for the two ecoregions. Shannon's H', the %EPT, Simpson's Index, and % Filterers were metrics not included in the list of macroinvertebrate metrics presented by Plafkin et al. (1989). The inclusion of these refined metrics provided a relatively good fit against the habitat assessment score. In addition, these metrics were found useful for both ecoregions with similar mean scores observed for the different stream types analyzed; thus demonstrating the utility of the ecological assessment approach. These findings suggest the necessity of refining biological metrics for specific regions of the country to take into account the natural regional variation observed for lotic systems (Hughes et al. 1990). We recommend that additional ecoregions within

Idaho, e.g., western forested mountains ecoregion, be included in future studies for analysis of among ecoregion variability.

We attempted further refinement of the macroinvertebrate metric by including measures from specific taxa. The results indicated some taxa to be specific by stream type, with twelve taxa determined important based on MDA and PCA. In addition, some taxa were present only in upland streams (e.g., *Rhithrogena*), whereas other taxa were found primarily in lowland and impacted sites (e.g., *Sialis* and Odonate larvae). However, the high variation in the presence and absence of specific taxa within and among stream types made scoring difficult, consequently little improvement was observed when the data were regressed against the habitat assessment score. These data suggest that further refinement of metrics based on specific taxa is necessary.

Six metrics for fish were found important for distinguishing among-stream types between the two ecoregions. These metrics focused primarily on the Salmonidae assemblage or degree of tolerant taxa in the fish assemblage. The metric score provided a good fit against the habitat assessment score. The metric score also suggested that habitats in the Snake River Plain ecoregion are more impacted than in the Northern Basin and Range ecoregion. However, the metrics were useful indicators of biological integrity for both ecoregions.

In summary, we found that refinement of the original biotic metrics (Plafkin et al. 1989) could account for regional differences in biotic assemblages necessary in the development of biological criteria for Idaho streams; for example, refining the fish metrics towards a predominantly Salmonidae assemblage. These refined biotic metrics (macroinvertebrates and fish) were sensitive to changes in aquatic habitat quality based on the modified habitat assessment evaluation. Habitat assessment was improved through inclusion of quantitative measures and little additional time was involved. A standardized methodology, using both qualitative and quantitative measures, is important for future refinement of habitat assessment procedures and biotic metrics. We found the present habitat assessment procedure to be biased towards detecting habitat quality for fish and inclusion of quantitative habitat measures increased the sensitivity of the habitat assessment for macroinvertebrates. The data suggest the current refined biotic metrics are suitable for monitoring biological integrity for streams in the Northern Basin and Range and Snake River Plain ecoregions. Analyses of additional ecoregions is needed before a uniform procedure for the entire state of Idaho is derived. Further, our data indicate subtle differences in habitat quality among ecoregions, implying the importance of using regional reference streams in the application of the rapid bioassessment procedure.

ACKNOWLEDGMENTS

A number of individuals assisted in the conduction of this project during the past two years. Donna Anderson, Jim Check, Paul Dey, Pete Koetsier, Deron Lawrence, Janet Mihuc, Tim Mihuc, Susannah Minshall, Greg Mladenka, and Dave Moser assisted in the field. Laboratory assistance was provided by Jim Check, Robert Gill, Justin Mann, Tim Mihuc, Dave Moser, Cecily Nelson, Mark Overfield, and Kelly Sant. Tracy Hillman, Pete Koetsier, and Scott Spalding verified fish identifications in the laboratory. We thank Kirk Koch, Steve Langenstein, Mike McIntyre, Mike Ingham, Pat Olmstead, Chip Corsey, Scott Grunder, and Al Van Vooren for information on prospective field sites. Special thanks go to Bill Clark, Tim Litke, Terry Maret, Mike McMasters, and Mike McIntyre of Idaho Department of Health and Welfare, Division of Environmental Quality for advice and assistance throughout the project.

LITERATURE CITED

APHA. 1989. Standard methods for the examination of water and wastewater. Washington D.C.

Barbour, M. T., and J. B. Stribling. In press. Habitat assessment approach for evaluating biological integrity of stream communities.

Burton, T. A. 1991. Monitoring stream substrate stability, pool volumes, and habitat diversity. Water Quality Monitoring Protocols-Report 3. Idaho Department of Health and Welfare, Division of Environmental Quality, Boise, Idaho. 8p.

Burton, T. A., E. Cowley, G. W. Harvey, and B. Wicherski. 1991. Protocols for evaluation and monitoring of stream/riparian habitats associated with aquatic communities in rangeland streams. Water Quality Monitoring Protocols-Report 4. Idaho Department of Health and Welfare, Division of Environmental Quality, Boise, Idaho. 31p.

Chandler, G. L., and T. R. Maret. 1991. Protocols for assessment of biotic integrity (fish) in Idaho streams. Water Quality Monitoring Protocols-Report 6. Idaho Division of Health and Welfare, Division of Environmental Quality, Boise, Idaho. 25p.

Clark, W. H. 1990. Coordinated nonpoint source water quality monitoring program for Idaho. Idaho Department of Health and Welfare, Division of Environmental Quality, Boise, Idaho. 139p.

Clark, W. H., and T. R. Maret. 1991. Protocols for assessment of biotic integrity (macroinvertebrates) in Idaho streams. Water Quality Monitoring Protocols-Report 5. Idaho Department of Health and Welfare, Division of Environmental Quality, Boise, Idaho. 18p.

Dunn, A. K. 1990. Water quality advisory working committee: designated stream segments of concern. Idaho Department of Health and Welfare, Division of Environmental Quality, Boise, Idaho. 52p.

Environmental Protection Service. 1990. Water quality program highlights: Ohio EPA's use of biological survey information. USEPA, Office of Water, Washington D.C. 4p.

Fausch, K. D., J. R. Karr, and P. R. Yant. 1984. Regional application of an index of biotic integrity based on stream fish communities. Trans. Am. Fish. Soc. 113:39-55.

Fisher, T. R. 1989. Application and testing of biotic integrity in northern and central Idaho headwater streams. M.Sc. Thesis, University of Idaho, Moscow, Idaho. 180p.

Gallant, A. L., T. R. Whittier, D. P. Larsen, J. M. Omernik, and R. B. Hughes. 1989. Regionalization as a tool for managing environmental resources. EPA/600/3-89/060.

Hilsenhoff, W. L. 1988. Rapid field assessment of organic pollution with a family level biotic index. J. N. Am. Benthol. Soc. 7:65-68.

Hughes, R. M., T. R. Whittier, C. M. Rohm, and D. P. Larsen. 1990. A regional framework for establishing recovery criteria. Environmental Management 14:673-683.

Karr, J. R. 1991. Biological integrity: a long neglected aspect of water resource management. Ecological Applications 1:66-84.

Karr, J. R., K. D. Fausch, P. L. Angermeier, P. R. Yant, and I. J.

Schlosser. 1986. Assessing biological integrity in running waters: a method and its rationale. Special Publication 5. Illinois Natural History Survey.

Plafkin, J. L., M. T. Barbour, K. D. Porter, S. K. Gross, and R. M. Hughes. 1989. Rapid bioassessment protocols for use in streams and rivers: benthic macroinvertebrates and fish. USEPA EPA/444/4-89-001.

Platts, W. S., W. F. Megahan, and G. W. Minshall. 1983. Methods for evaluating stream, riparian, and biotic conditions. Gen. Tech. Rep. INT-138. Ogden, Utah. USDA, Forest Service, Intermountain Forest and Range Experiment Station. 70p.

Robinson, C. T., and G. W. Minshall. 1986. Effects of disturbance frequency on stream benthic community structure in relation to canopy cover and season. J. N. Am. Benthol. Soc. 5:237-248.

Robinson, C. T., and G. W. Minshall. 1991. Biological metric development for the assessment of nonpoint pollution in the Snake River ecoregion of Southern Idaho. Final Report submitted to Idaho Division of Environmental Quality. 75p.

Statsoft: Statistica. 1991. Complete statistical system with data base management and graphics. Statsoft, Inc., Tulsa, Ok.

Strahler, A. N. 1957. Quantitative analysis of watershed geomorphology. Am. Geophys. Union Trans. 38:913-920.

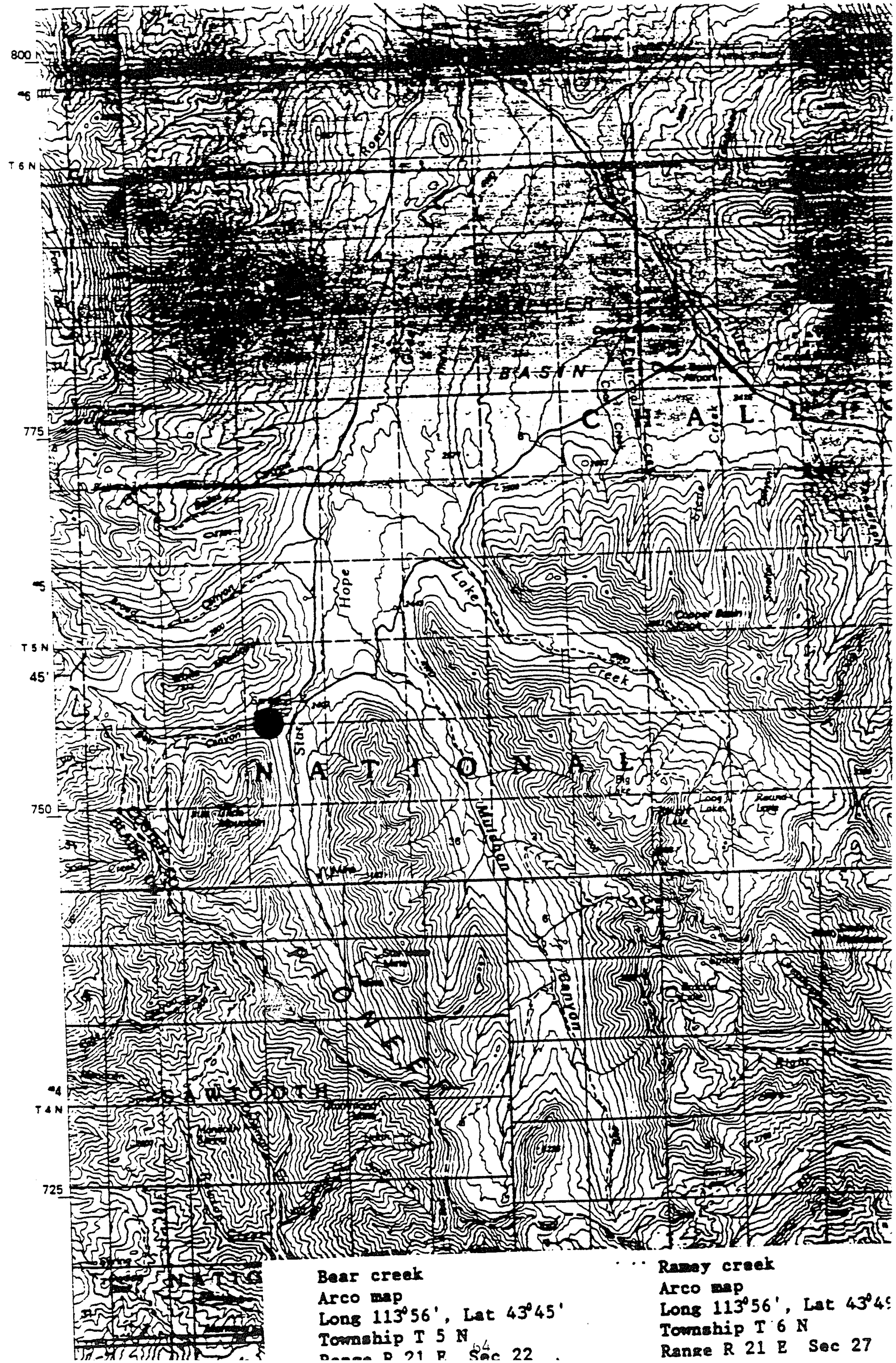
Waters, T. F., and R. J. Knapp. 1961. An improved bottom sampler. Trans. Am. Fish. Soc. 90:225-226.

Winget, R. N., and F. A. Magnum. 1979. Biotic condition index: integrated biological, physical, and chemical stream parameters for management. In Aquatic ecosystem inventory:

Macroinvertebrate analysis. U. S. Forest Service Intermountain Region Contract No. 40-84-M8-8-524. Brigham Young University, Provo, Utah.

Wisseman, R. W. 1990. Freshwater macroinvertebrates species list including tolerance values and functional feeding group designations for use in rapid bioassessment protocols. Report No. 11075.05 USEPA, Assessment and Watershed Protection Division, Washington D. C.

Zar, J. H. 1984. Biostatistical Anlysis, 2nd edition. Prentice-Hall, Inc. Englewood Cliffs, New Jersey.



Bear creek
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Township T 5 N
Range R 21 E Sec 22

Ramey creek
Arco map
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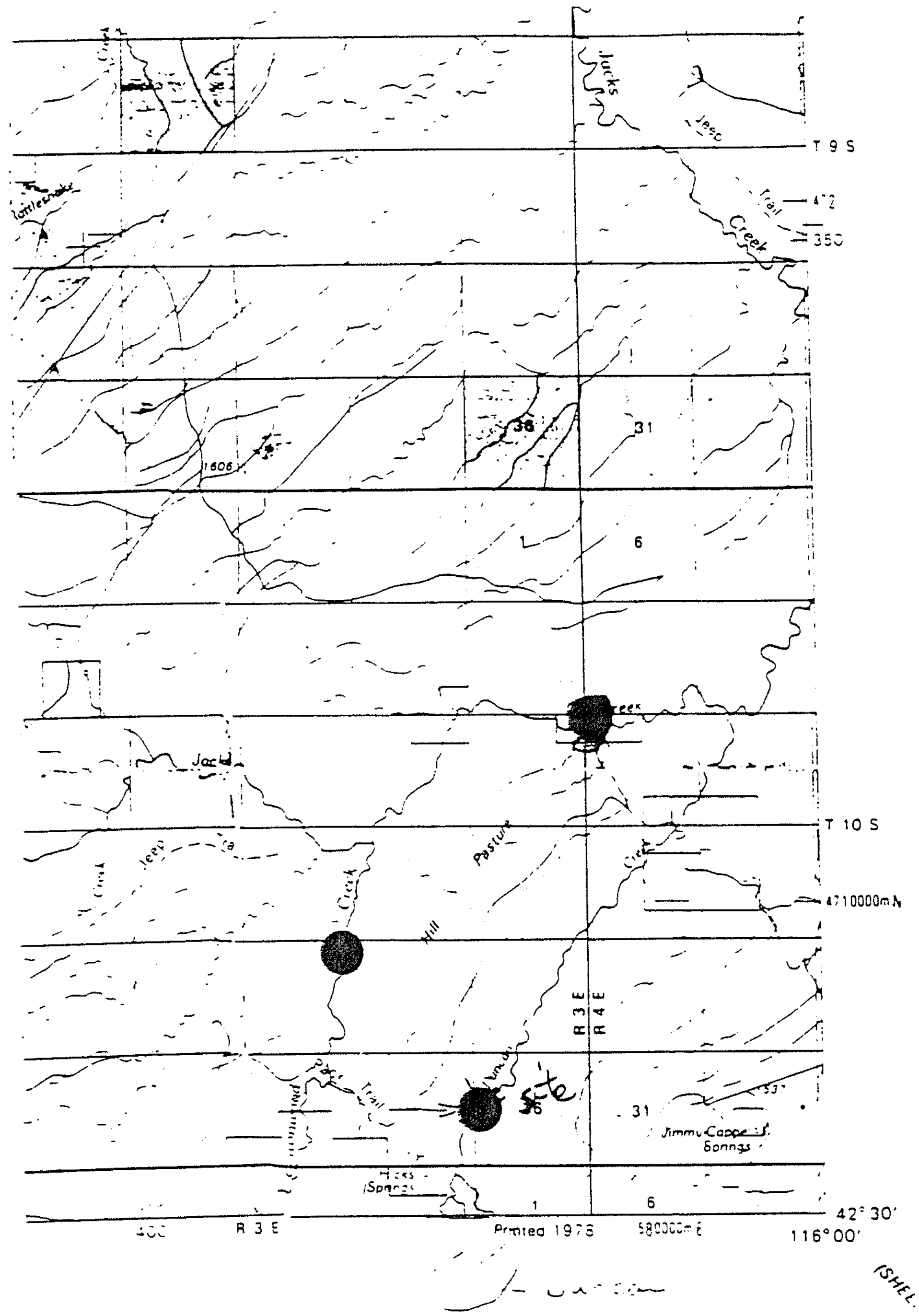
Township T 6 N
Range R 21 E Sec 27



ROAD CLASSIFICATION

Primary highway, hard surface

Secondary highway, hard surface

Light-duty road, hard or improved surface

Street, other road

Trail

Interstate route U.S. route State route

Big Jack creek
Triangle Quadrangle
Long 116°02', Lat 42°34'
Township T 10 S
Range R 4 E Sec 18

Cottonwood creek
Triangle Quadrangle
Long 116°05', Lat 42°32'
Township T 10 S
Range R 3 E Sec 27

Duncan creek
Triangle Quadrangle
Long 116°04', Lat 42°31'
Township T 10 S
Range R 3 E Sec 36

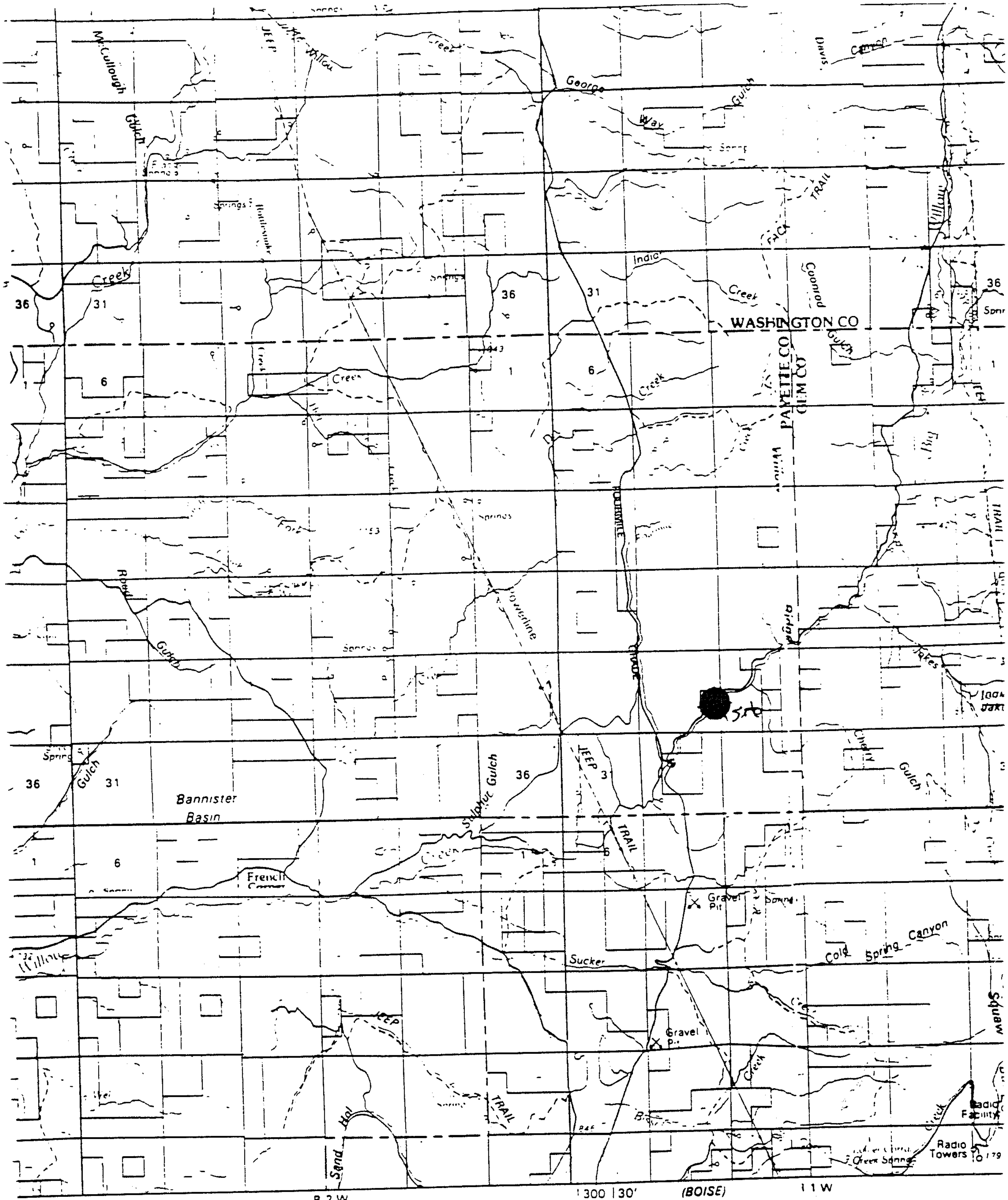
TRIANGLE, IDAHO

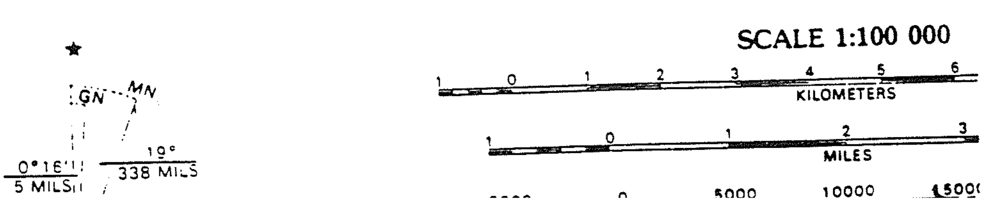
NE/4 JORDAN VALLEY (NK 11-9) 1:250 000-SCALE MAP

N4230-W11600/30 x 60

1978

SURFACE MANAGEMENT STATUS





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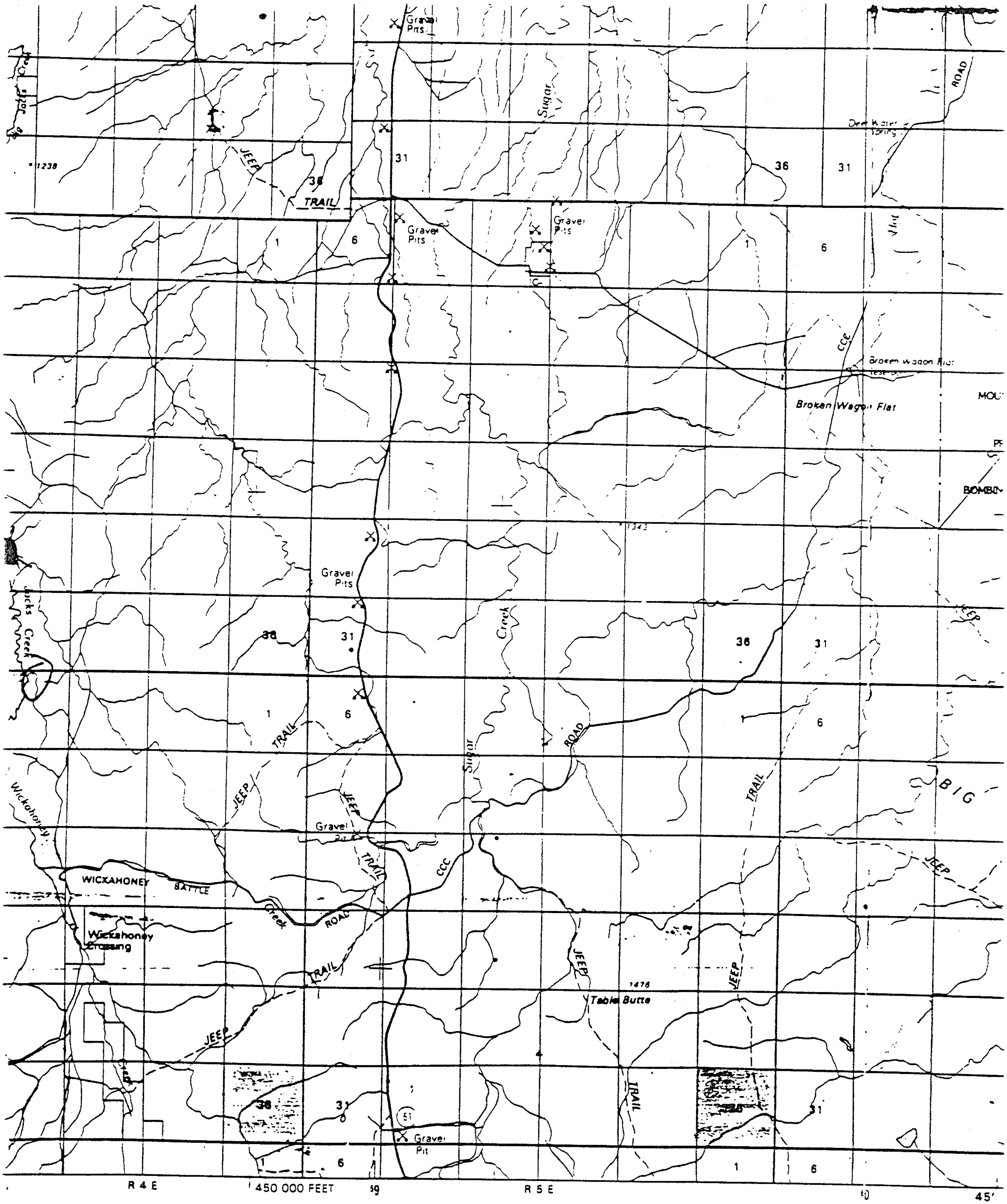
Range R 1 W Sec 29



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...mpiled in 1975 from USGS 1:62 500-scale topographic maps
...ed 1947-1959. See index for dates of individual maps

Big Jack creek
Glenna Ferry Quadrangle
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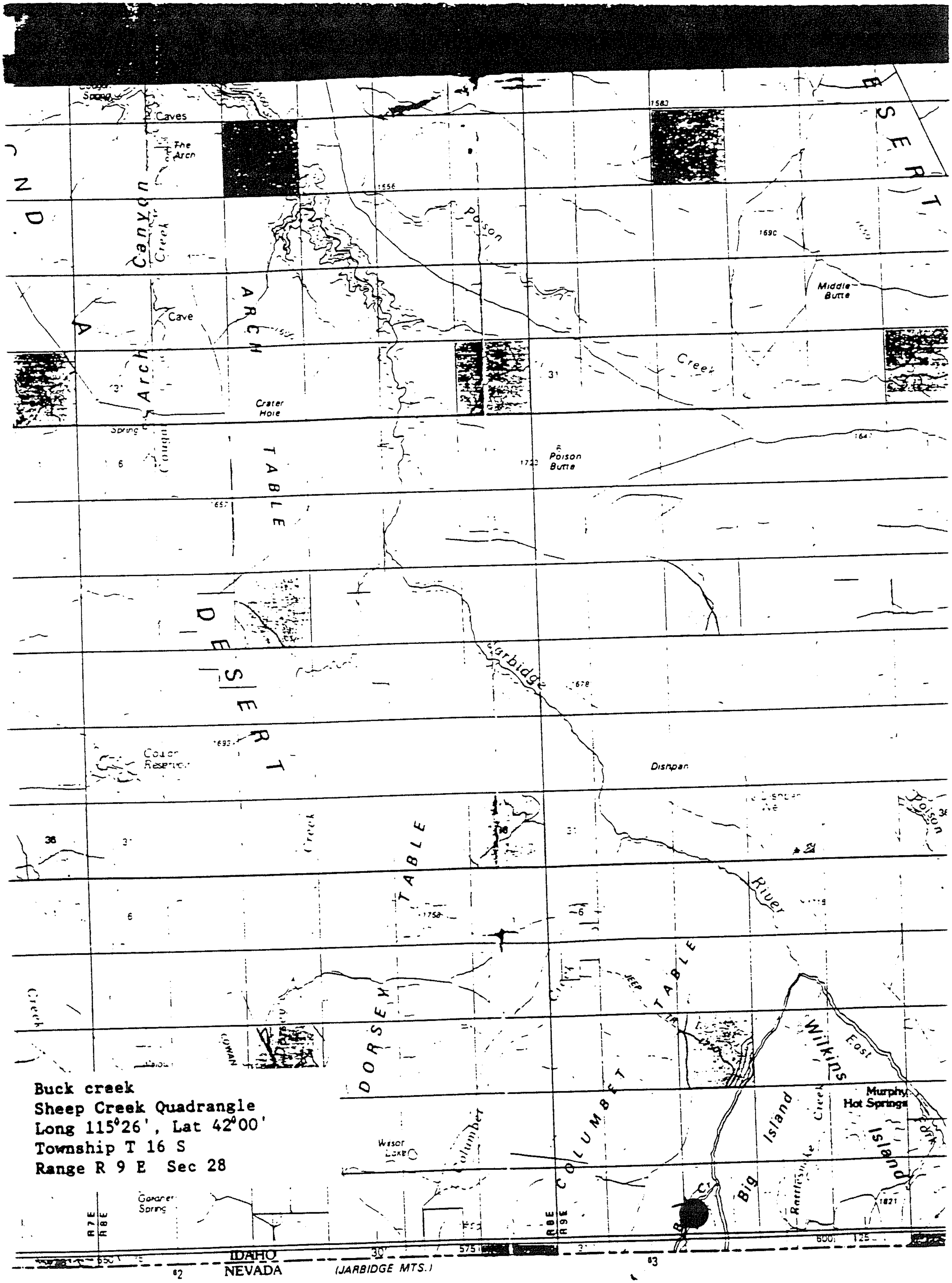
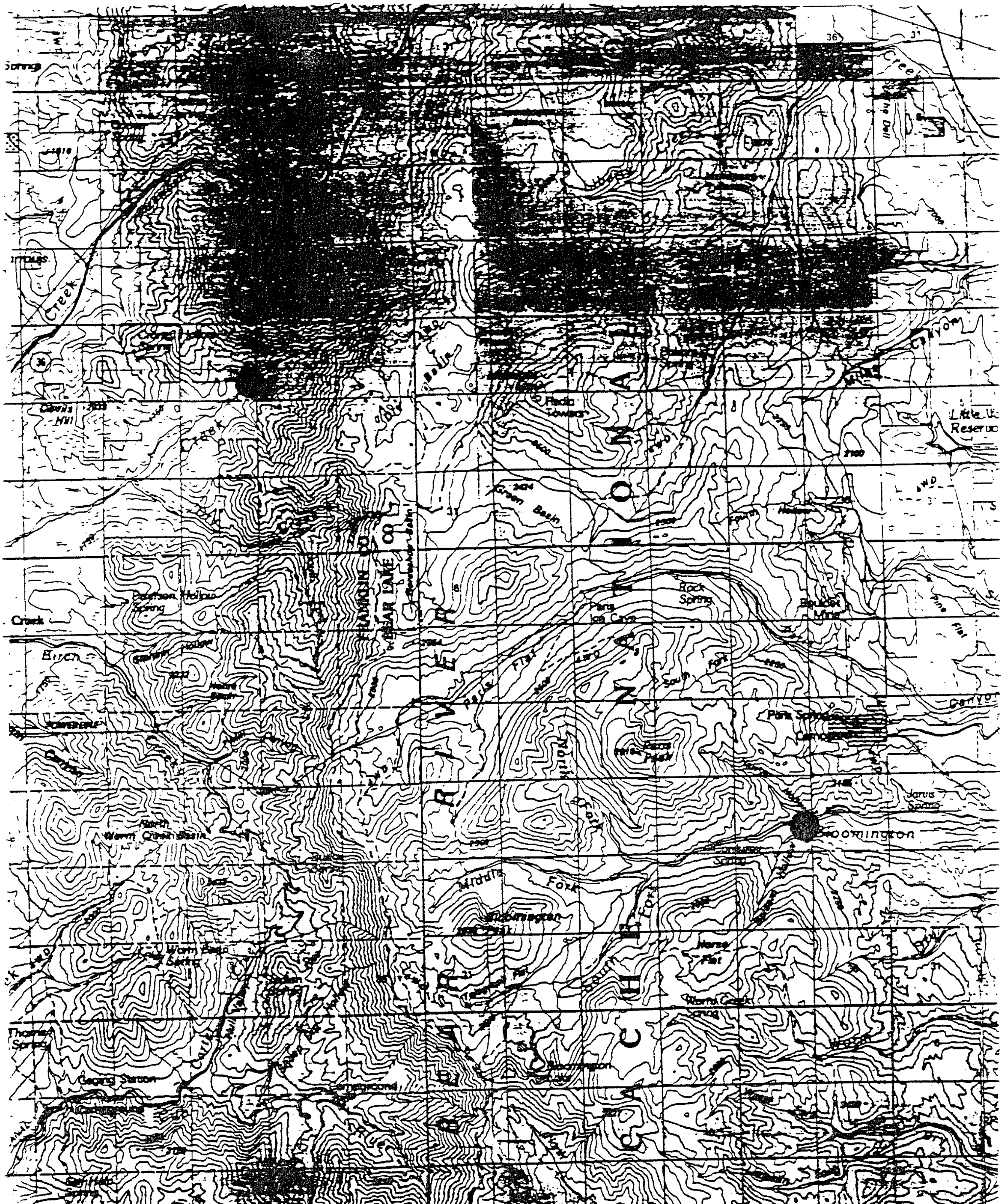
Township T 9 S
Range R 4 E Sec 28



Buck creek
Sheep Creek Quadrangle
Long 115°26', Lat 42°00'
Township T 16 S
Range R 9 E Sec 28



Mink creek
Preston map
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Range R 41 E Sec 22

Bloomington creek
Preston map
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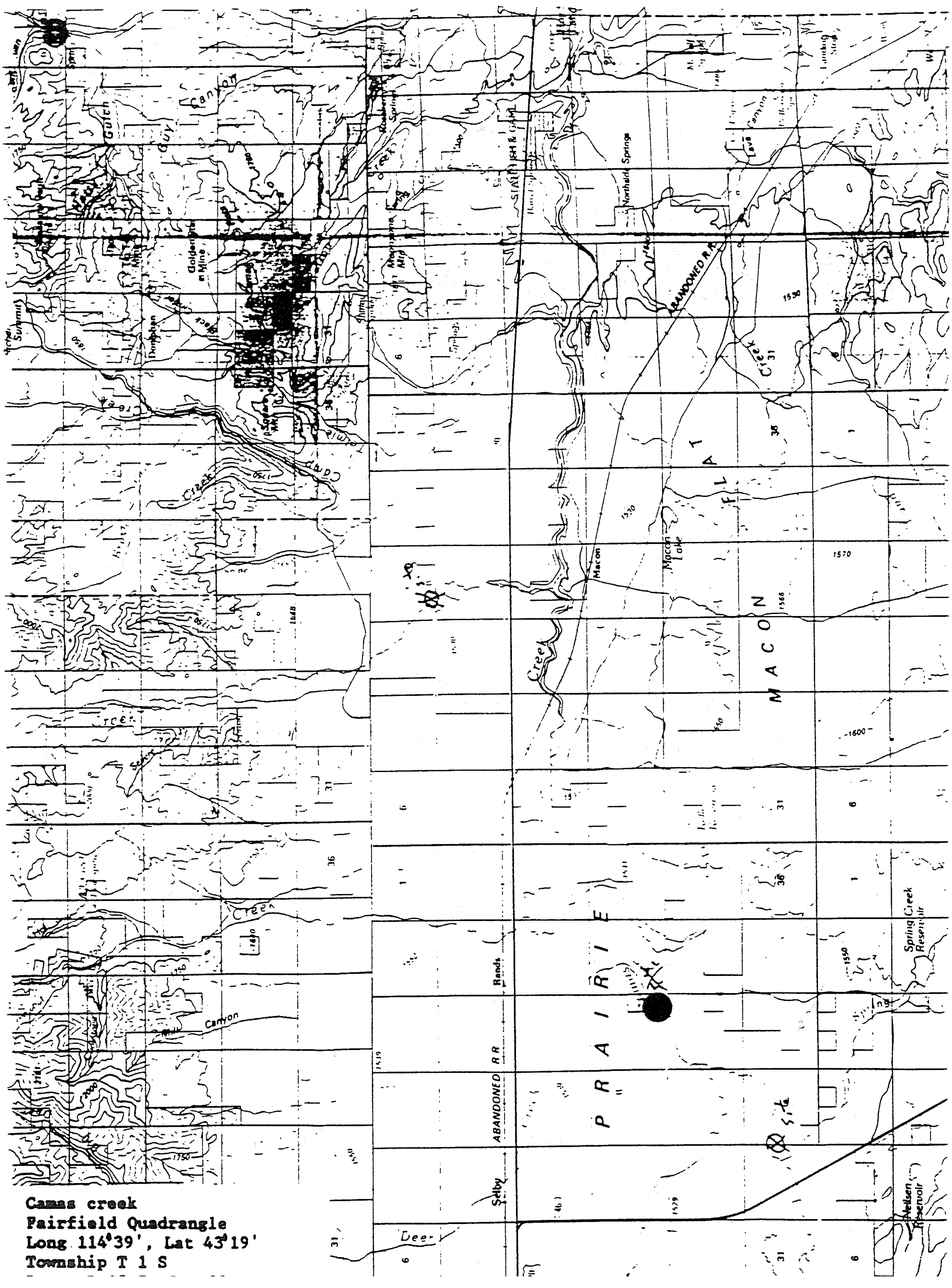
Township T 14 S
Range R 42 E Sec 23



Camas creek
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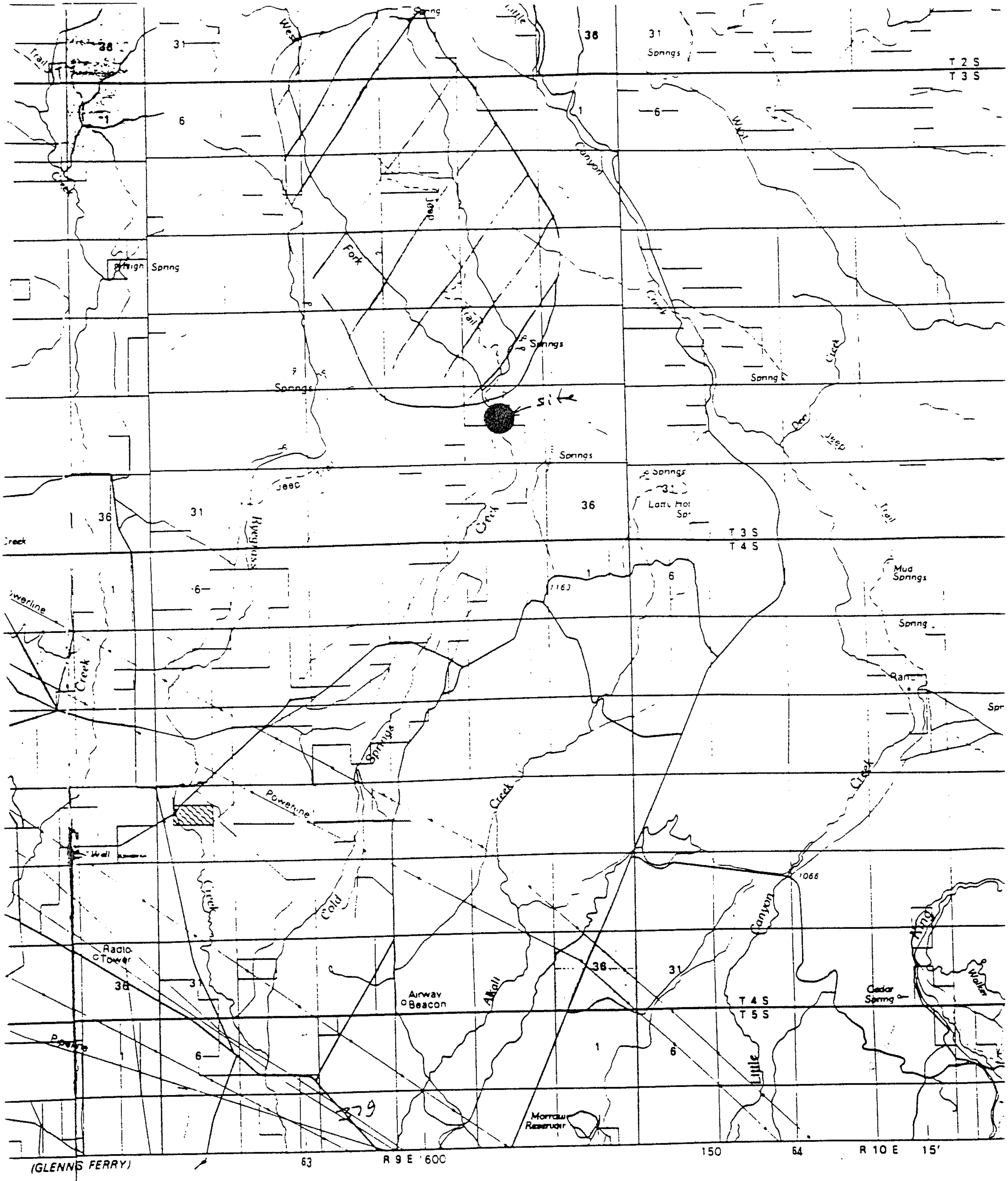
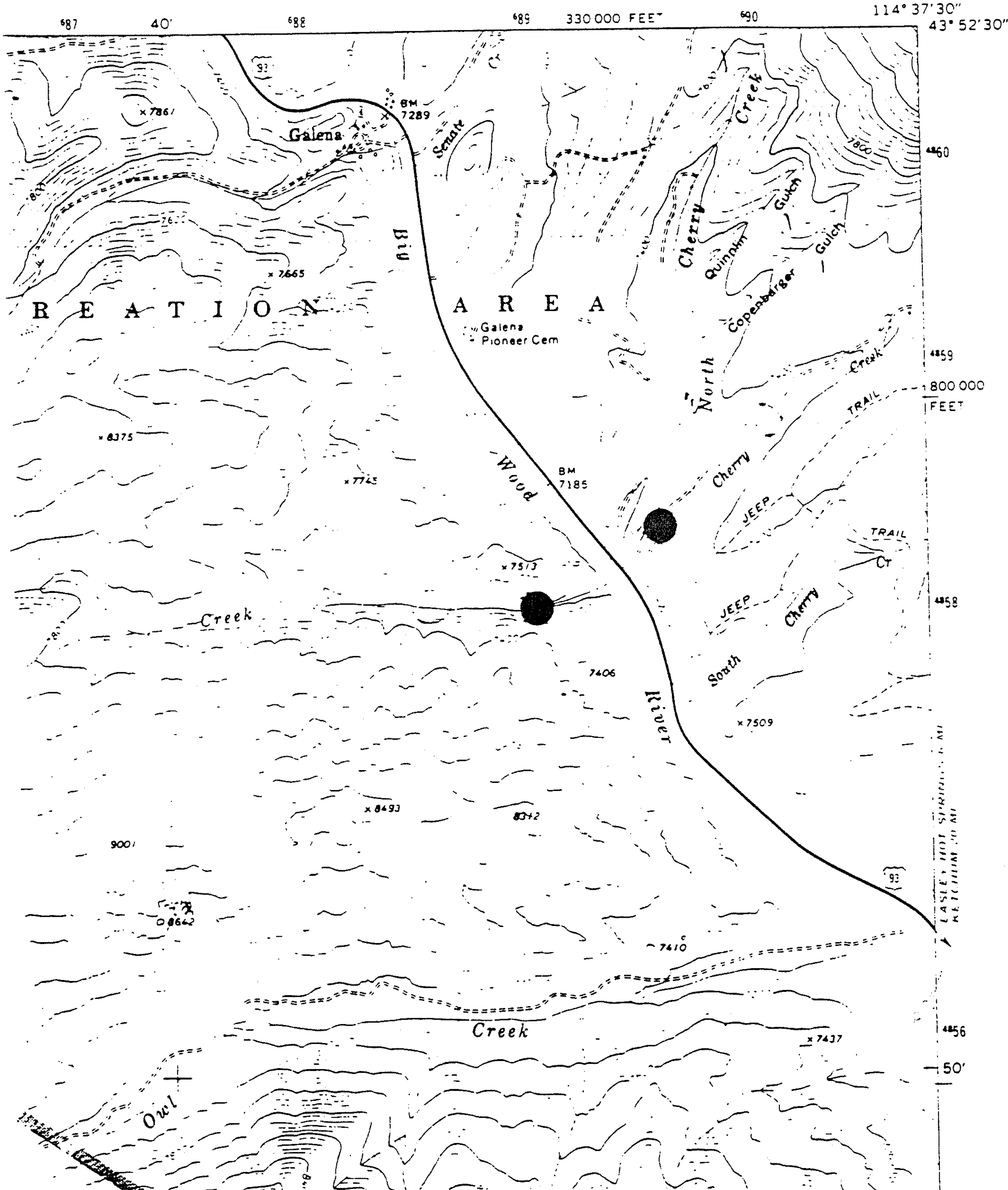
Township T 1 S



Cold Springs creek
Mountain Home Quadrangle
Long 115°21', Lat 43°08'
Township T 3 S
Range R 9 E Sec 26

Wayne Minshall

GALENA QUADRANGLE
IDAHO
7.5 MINUTE SERIES (TOPOGRAPHIC)



Coyote creek
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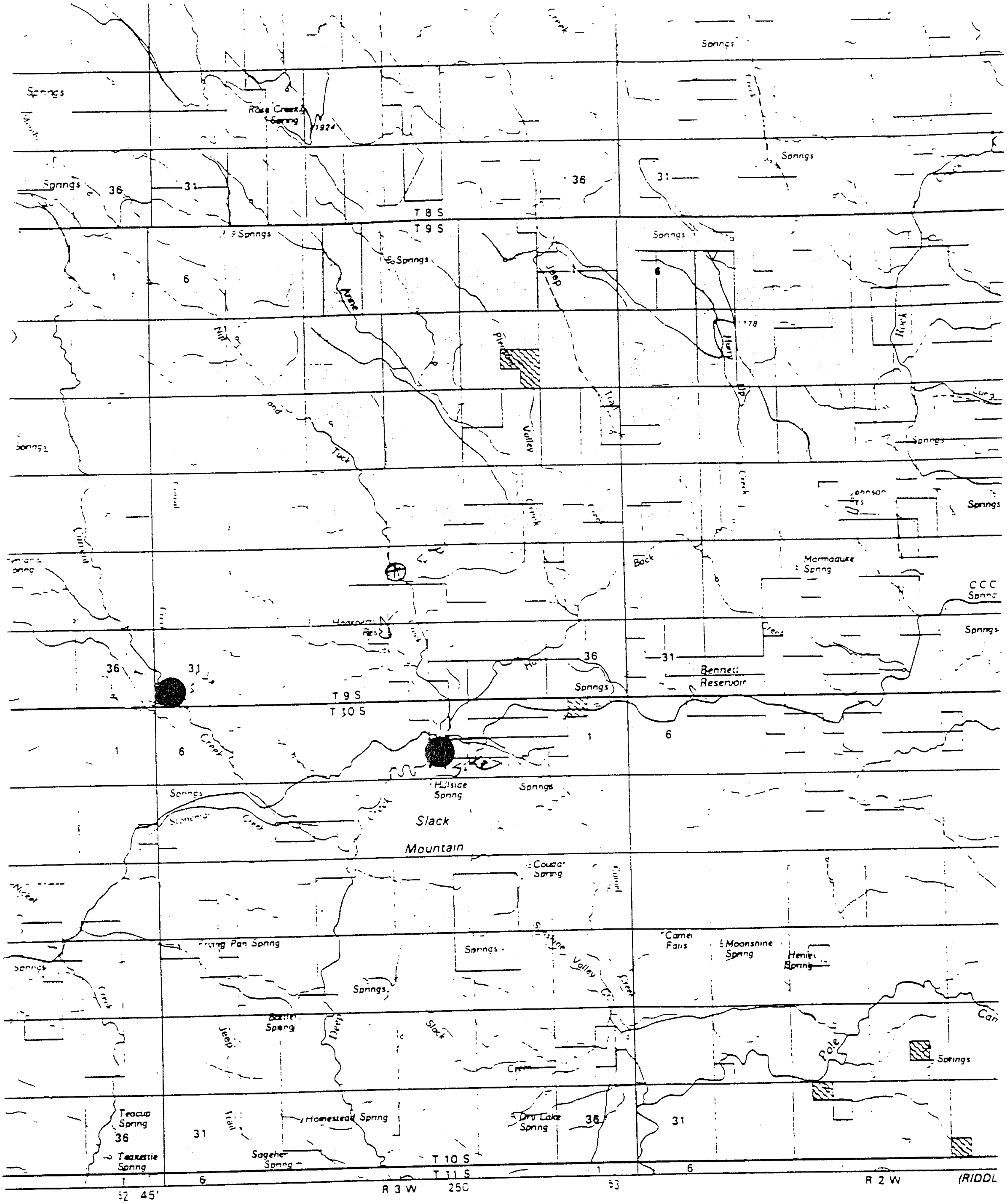
Township T 6 N

Cherry creek
Galena Quadrangle
Long 114°38', Lat 43°51'
Township T 6 N



Current creek
Triangle Quadrangle
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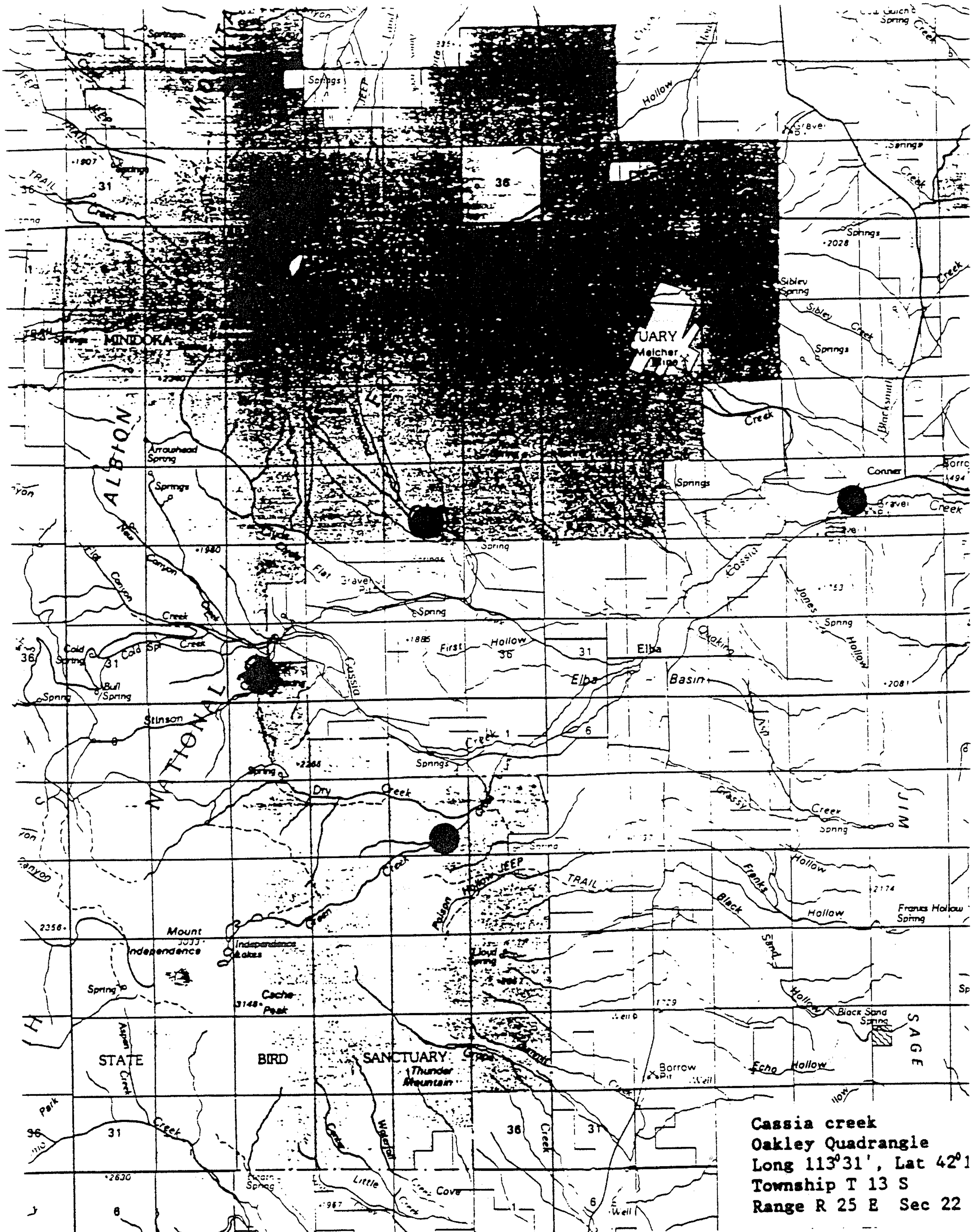
Township T 9 S
Range R 3 W Sec 31

Deep creek
Triangle Quadrangle
Long 116°41', Lat 42°35'
Township T 10 S
Range R 3 W Sec 3

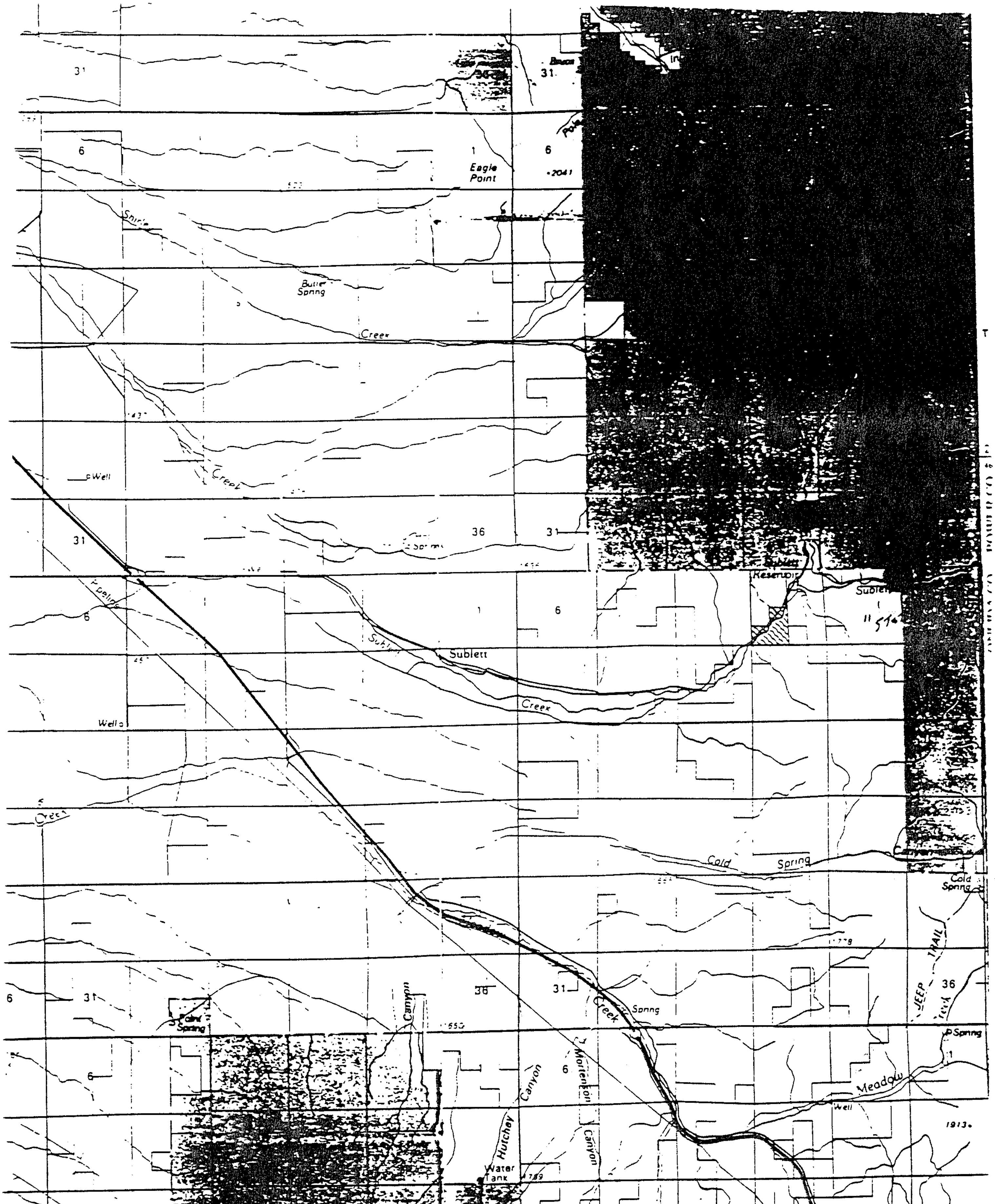


Cassia creek
Oakley Quadrangle
Long 113°31', Lat 42°1
Township T 13 S
Range R 25 E Sec 22

Green creek
Oakley Quadrangle
Long 113°37', Lat 42°13'
Township T 14 S
Range R 24 E Sec 11

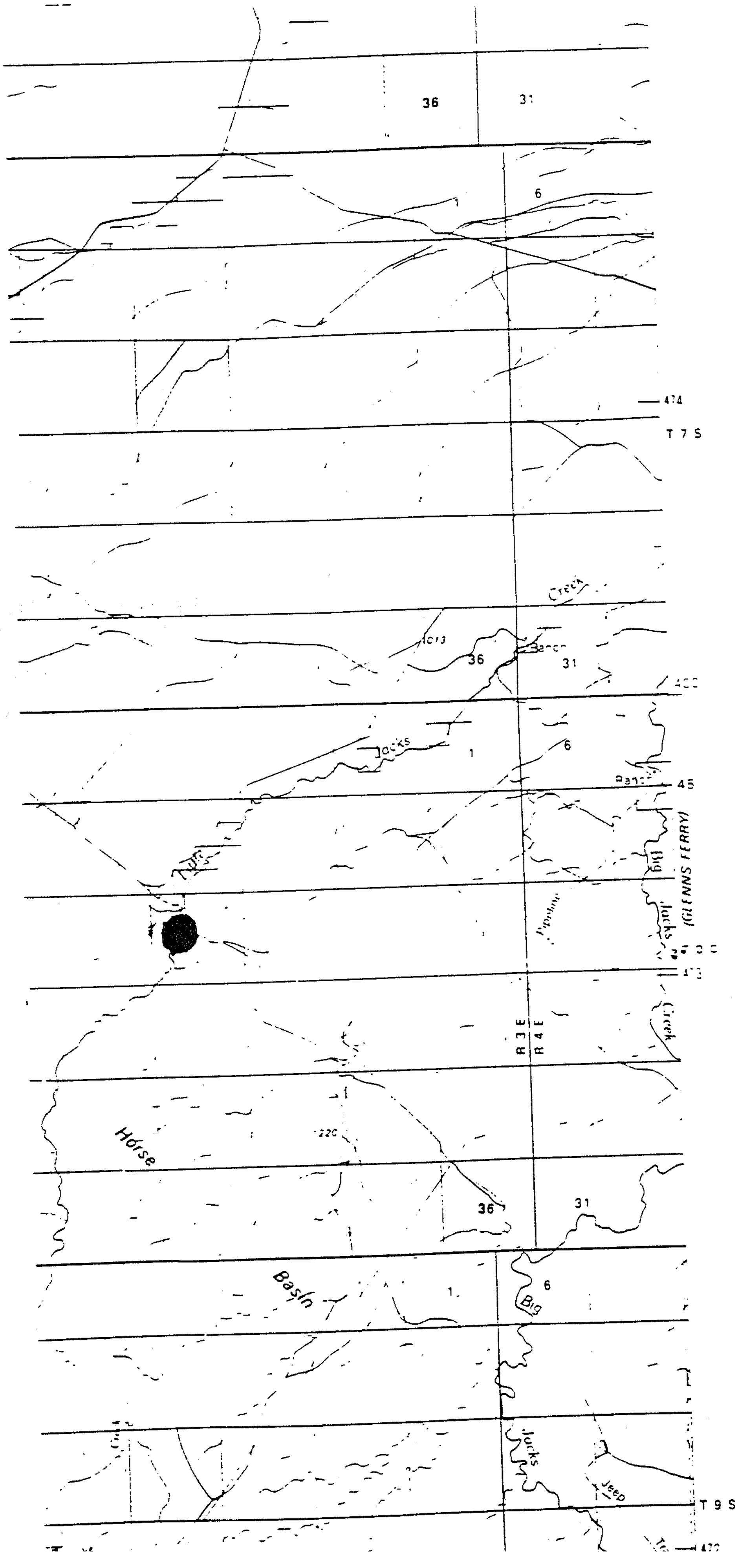
Stinson creek
Oakley Quadrangle
Long 113°40', Lat 42°15'
Township T 13 S
Range R 24 E Sec 33

Cottonwood creek
Oakley Quadrangle
Long 113°37', Lat 4
Township T 13 S
Range R 24 E Sec 2



Lake Fork creek
Oakley Quadrangle
Long 113°02', Lat 42°20'
Township T 12 S
Range R 29 E Sec 34

Station Fork creek
Oakley Quadrangle
Long 113°01', Lat 42°19'
Township T 13 S
Range R 29 E Sec 2



Corps of Engineers	
Wildlife Refuges	NONE
Bankhead-Jones Land Use Lands (L.L. Lands)	NONE
Tennessee Valley Authority	NONE
Patented Lands	
State Lands	
Bureau of Reclamation	
Power Withdrawals and Classifications	NONE
Federal Agency Protective Withdrawals	NONE
Public Water Reserves	
Energy Research and Development Administration (ERDA)	NONE
Oregon & California Lands (O&C Lands) Administered By US Forest Service	NONE
Radio & Air Facilities	NONE
Miscellaneous	NONE
State, County, City, Wildlife, Park and Outdoor Recreation Areas	NONE
Acquired Lands (By Administering Agency)	NONE

Little Jack creek
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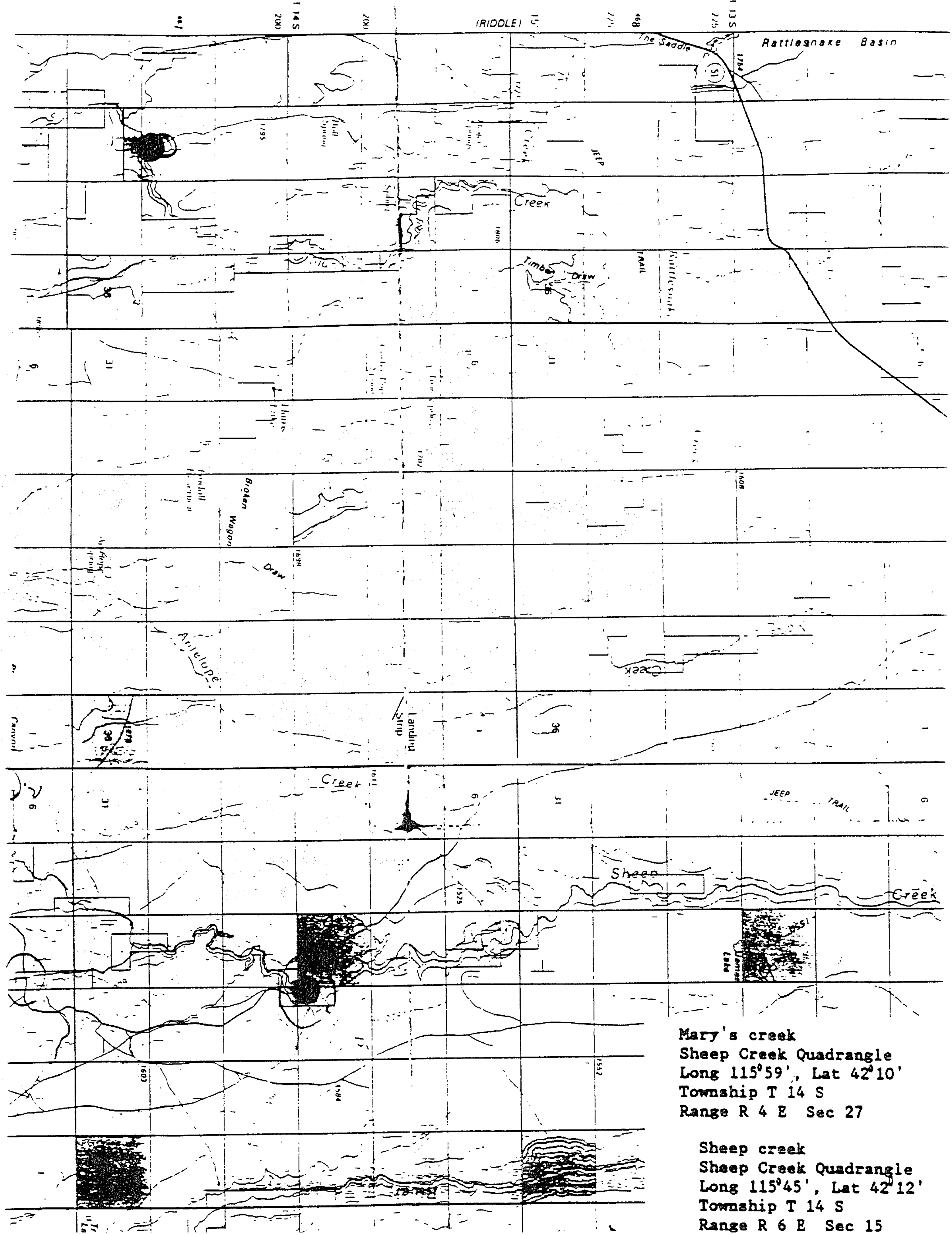
Township T 8 S
Range R 3 E Sec 16



Mary's creek
Sheep Creek Quadrangle
Long 115°59', Lat 42°10'
Township T 14 S
Range R 4 E Sec 27

Sheep creek
Sheep Creek Quadrangle
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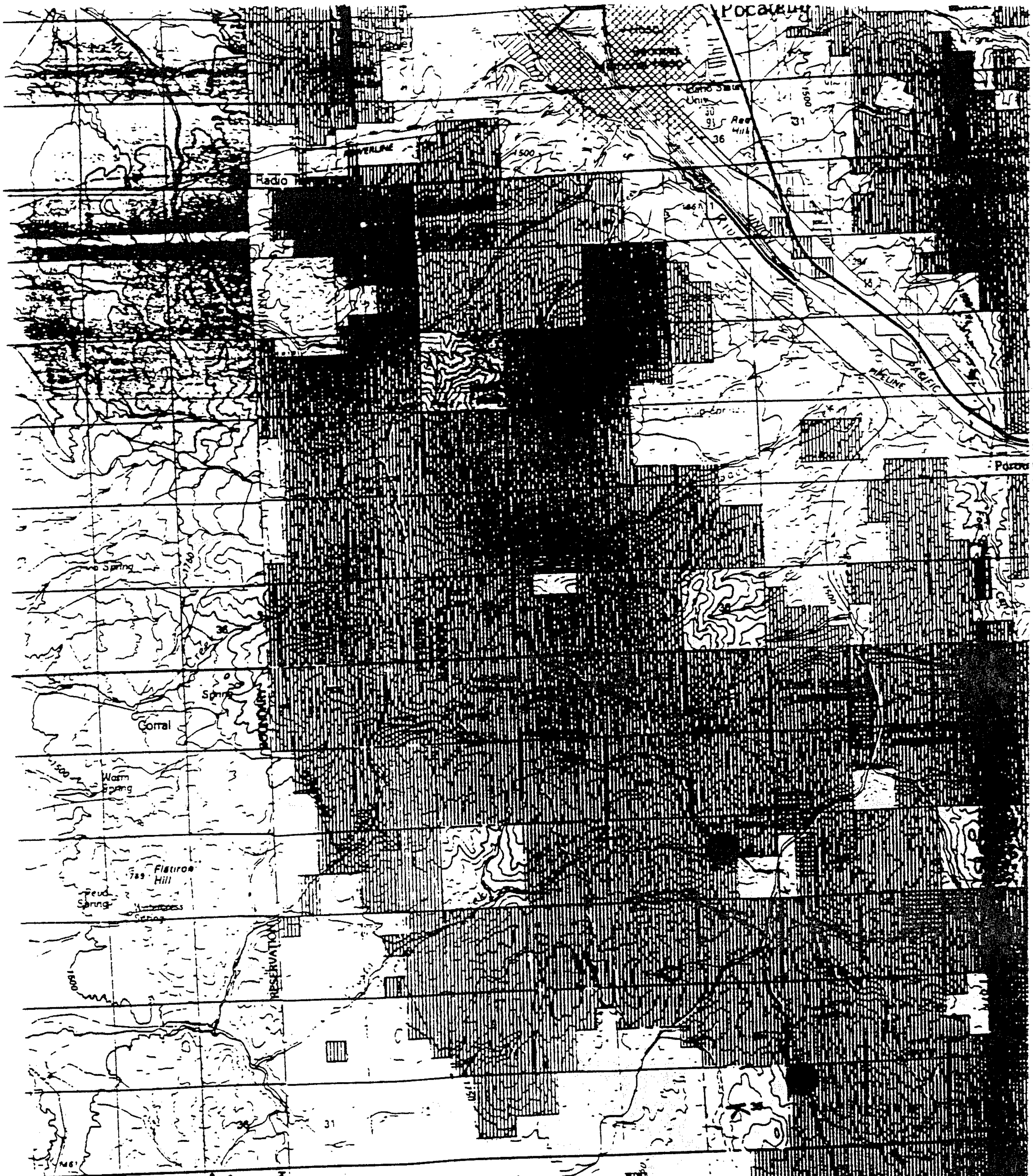
Township T 14 S
Range R 6 E Sec 15



S F Mink creek
Pocatello map
Long 112°25', Lat 42°41'
Township T 8 S
Range R 35 E   Sec 31

W F Mink creek
Arco map
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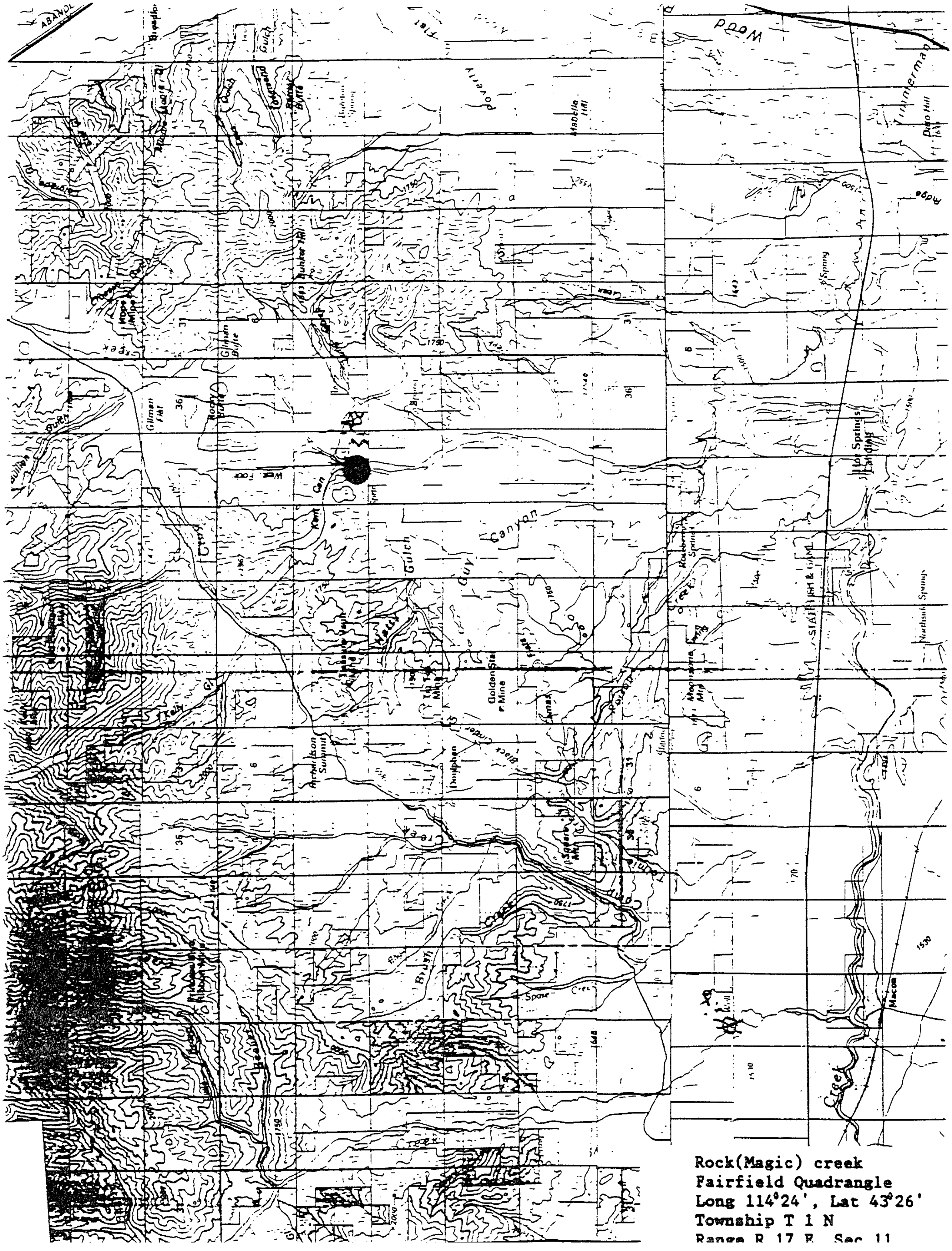
Township T 8 S
Range R 34 E   Sec 13



Rock(Magic) creek
Fairfield Quadrangle
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Township T 1 N
Range R 17 E, Sec 11

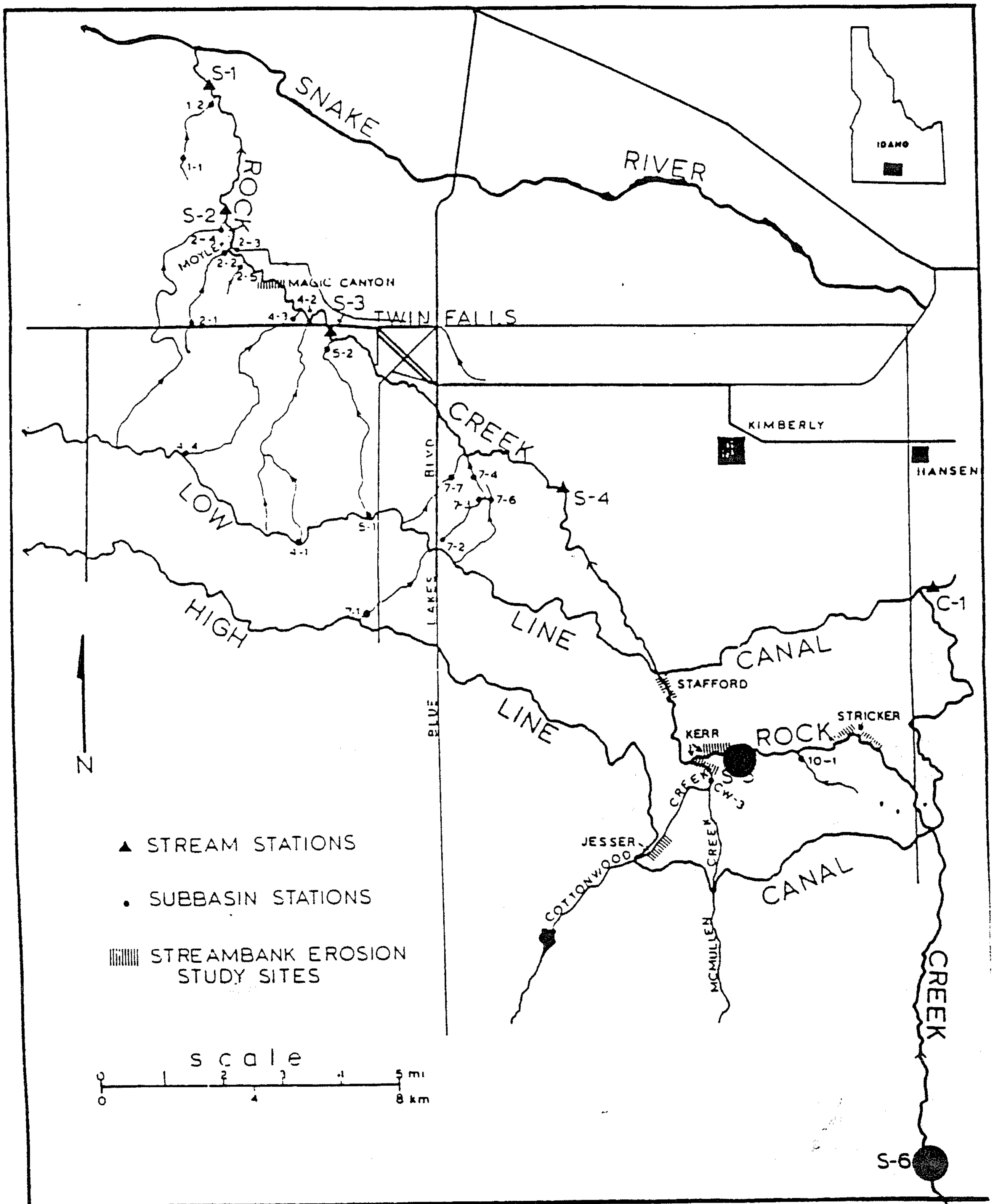
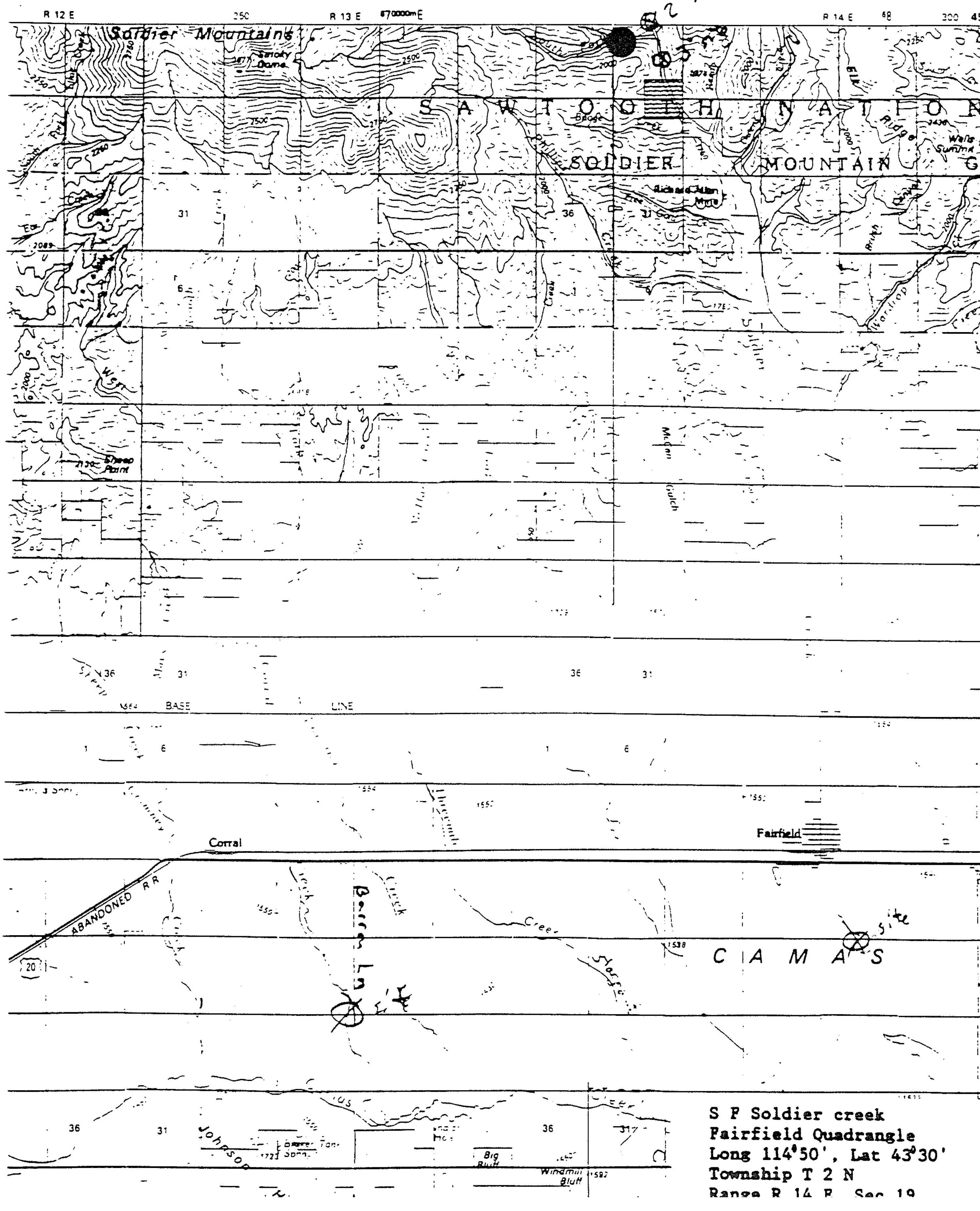


Figure 1 Map of the Rock Creek Rural Clean Water Program study area, Twin Falls County, Idaho. Rock Creek and subbasin sample stations are shown as well as the areas selected for stream bank erosion study.

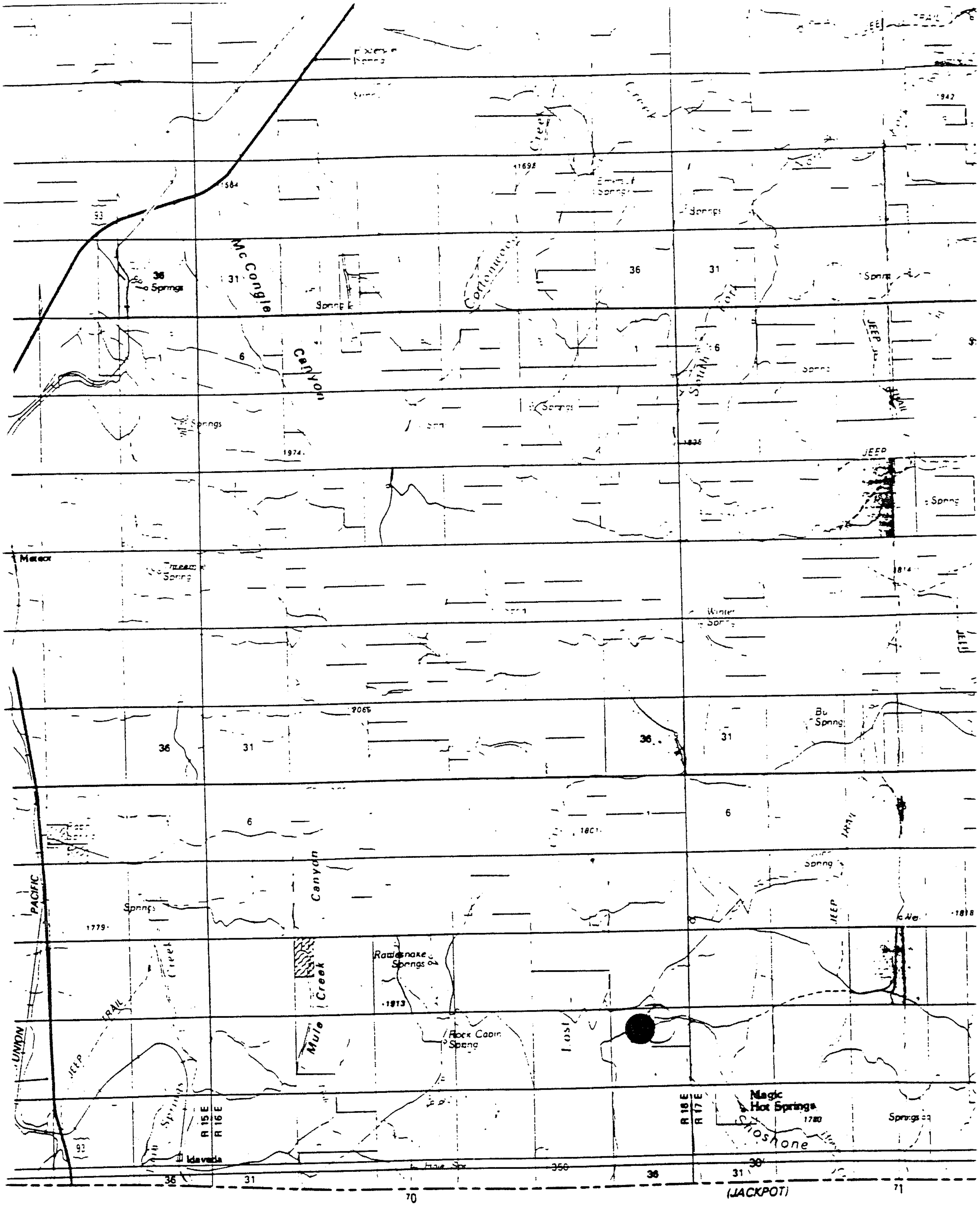
Rock(Twin) creek

Long	Long	Long
114°21'52"	114°18'15"	114°14'55"

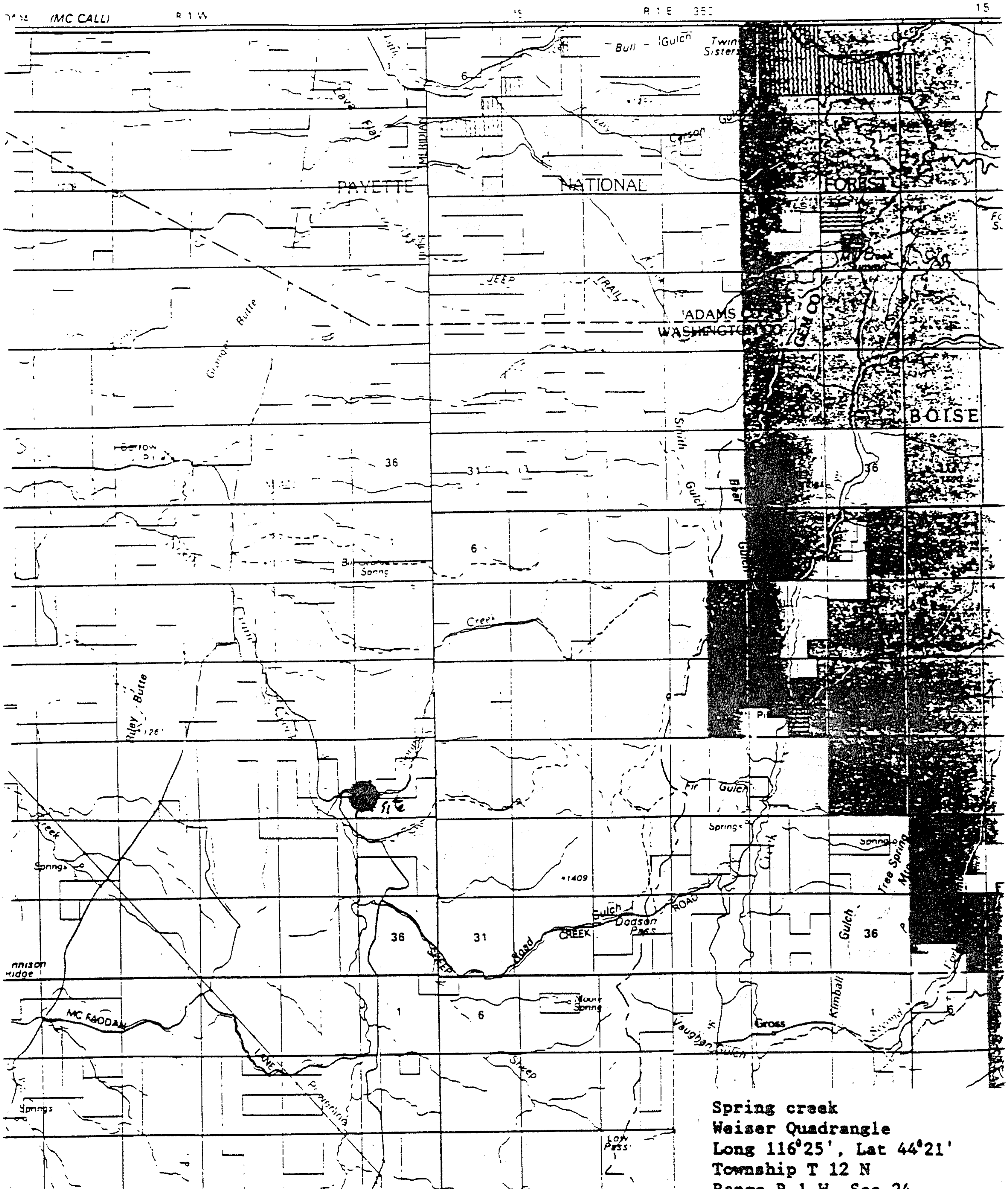
UNITED STATES
EPARTMENT OF THE INTERIOR
;UREAU OF LAND MANAGEMENT



S F Soldier creek
Fairfield Quadrangle
Long 114°50', Lat 43°30'
Township T 2 N
Range R 14 E Sec 19



Shoshone creek
Rogerson Quadrangle
Long 114°33', Lat 42°01'
Township T 16 S
Range R 16 E, Sec 24



Spring creek
Weiser Quadrangle
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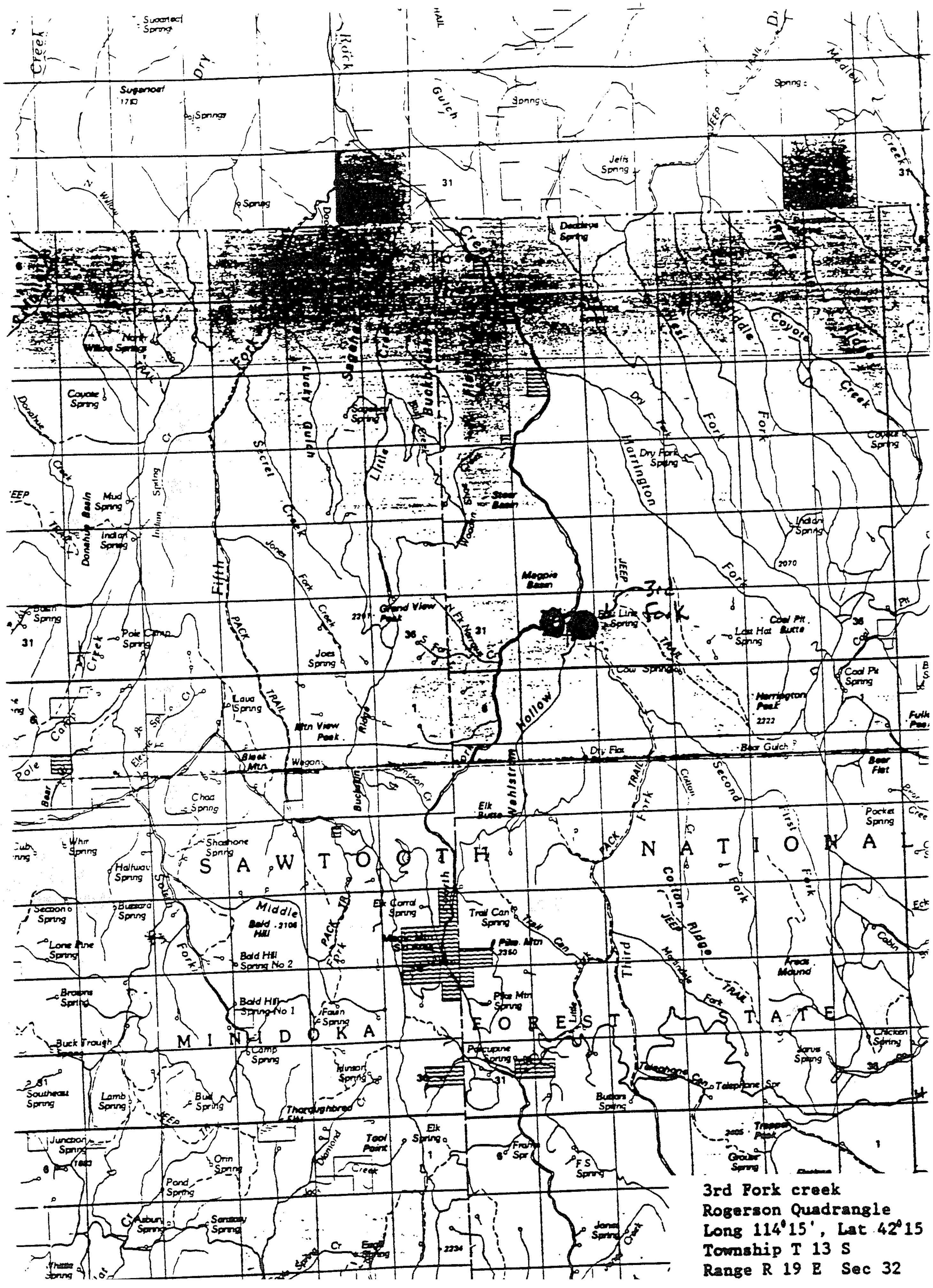
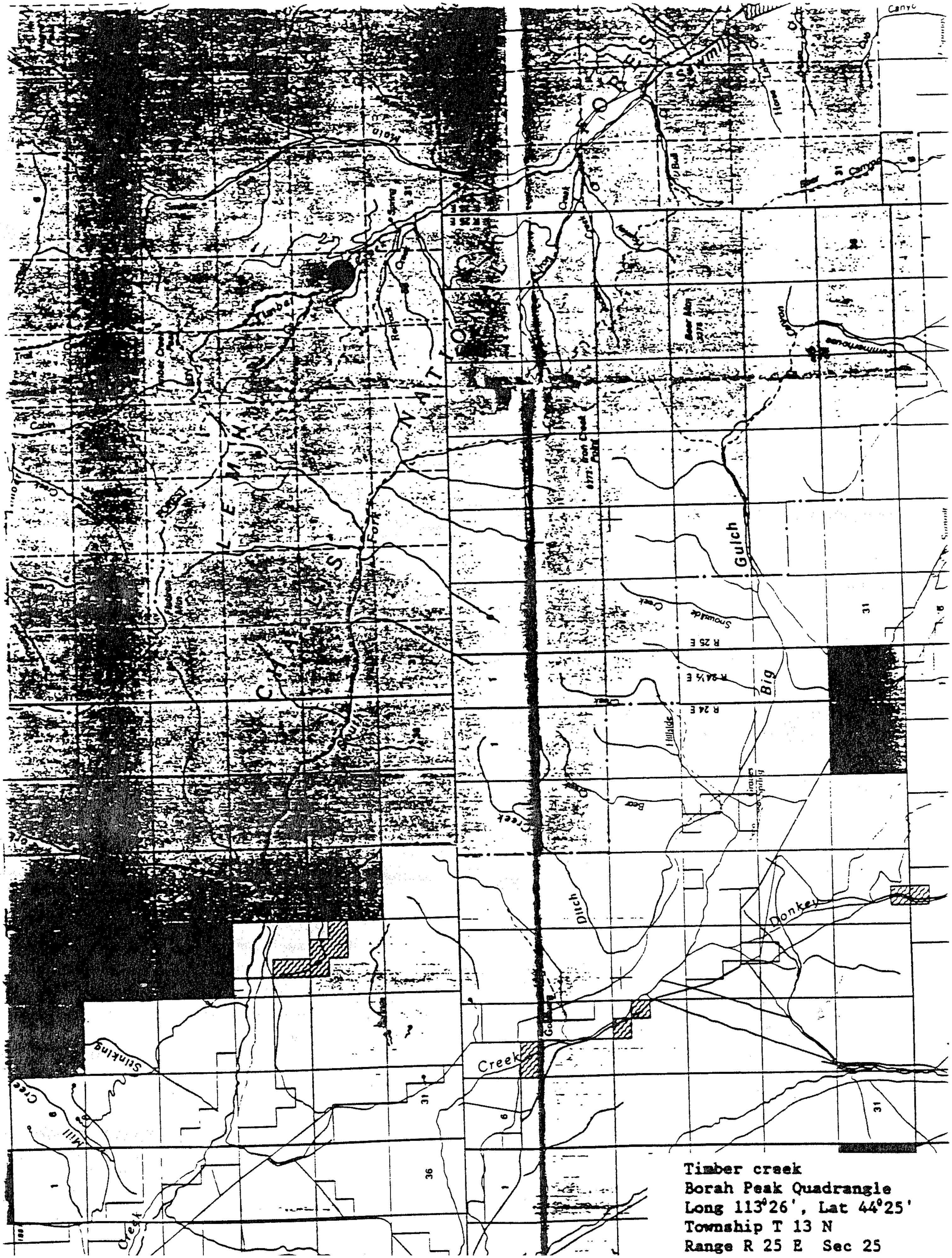
Township T 12 N
Range R 1 W, Sec 24



3rd Fork creek
Rogerson Quadrangle
Long 114°15', Lat 42°15
Township T 13 S
Range R 19 E Sec 32



Timber creek
Borah Peak Quadrangle
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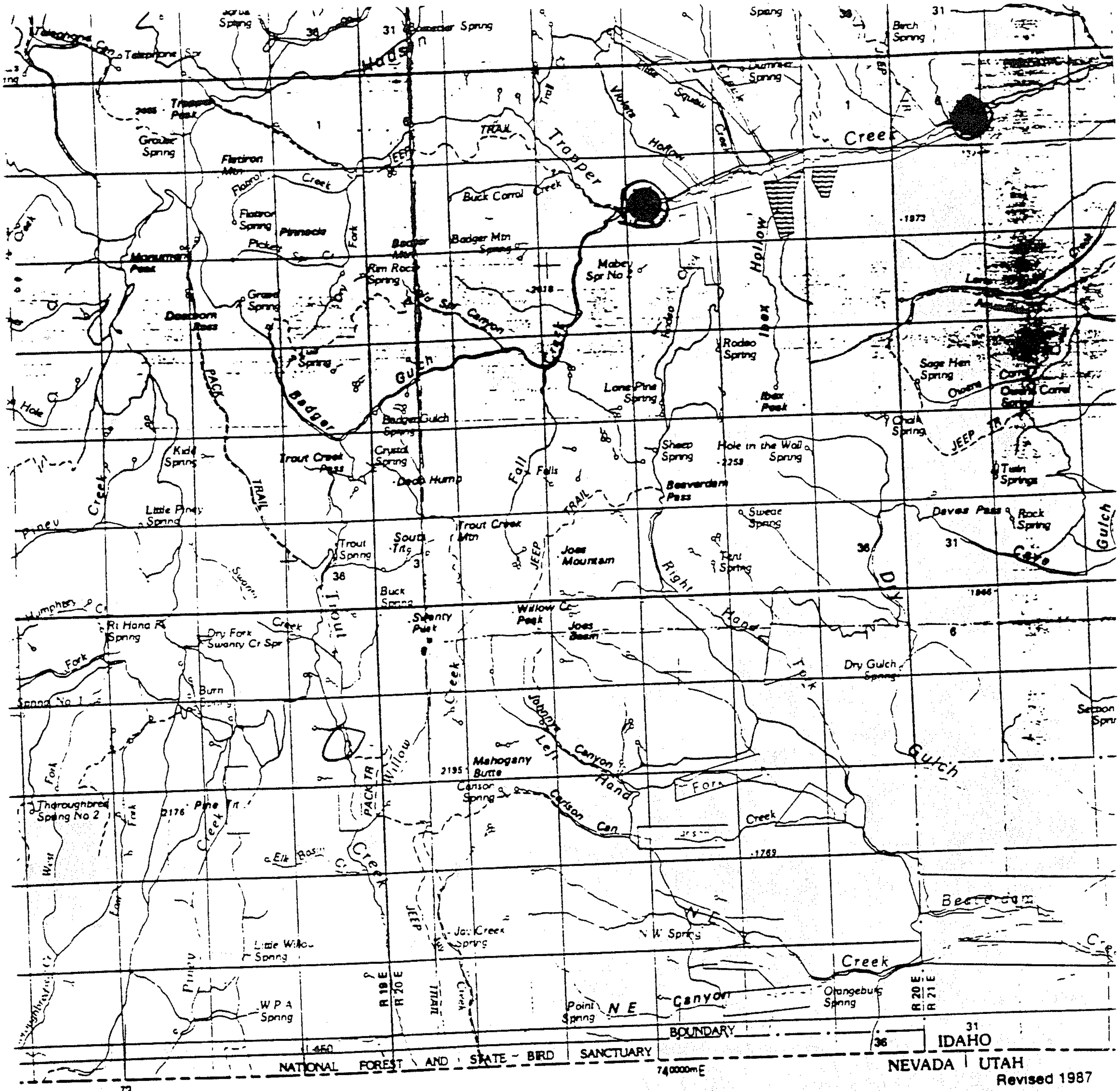
Township T 13 N
Range R 25 E Sec 25



ROAD CLASSIFICATION

Primary highway, hard surface
Secondary highway, hard surface
Light-duty road, hard or improved surface
Street or other road
Trail
Interstate Route
U.S. Route
State R

LEGEND

Perennial stream, lake
Intermittent stream, lake
Village or locality
Landmark structure

ROGERSON, IDAHO-N

SE/4 TWIN FALLS (NK 11-6) 1:250 000-SCAL

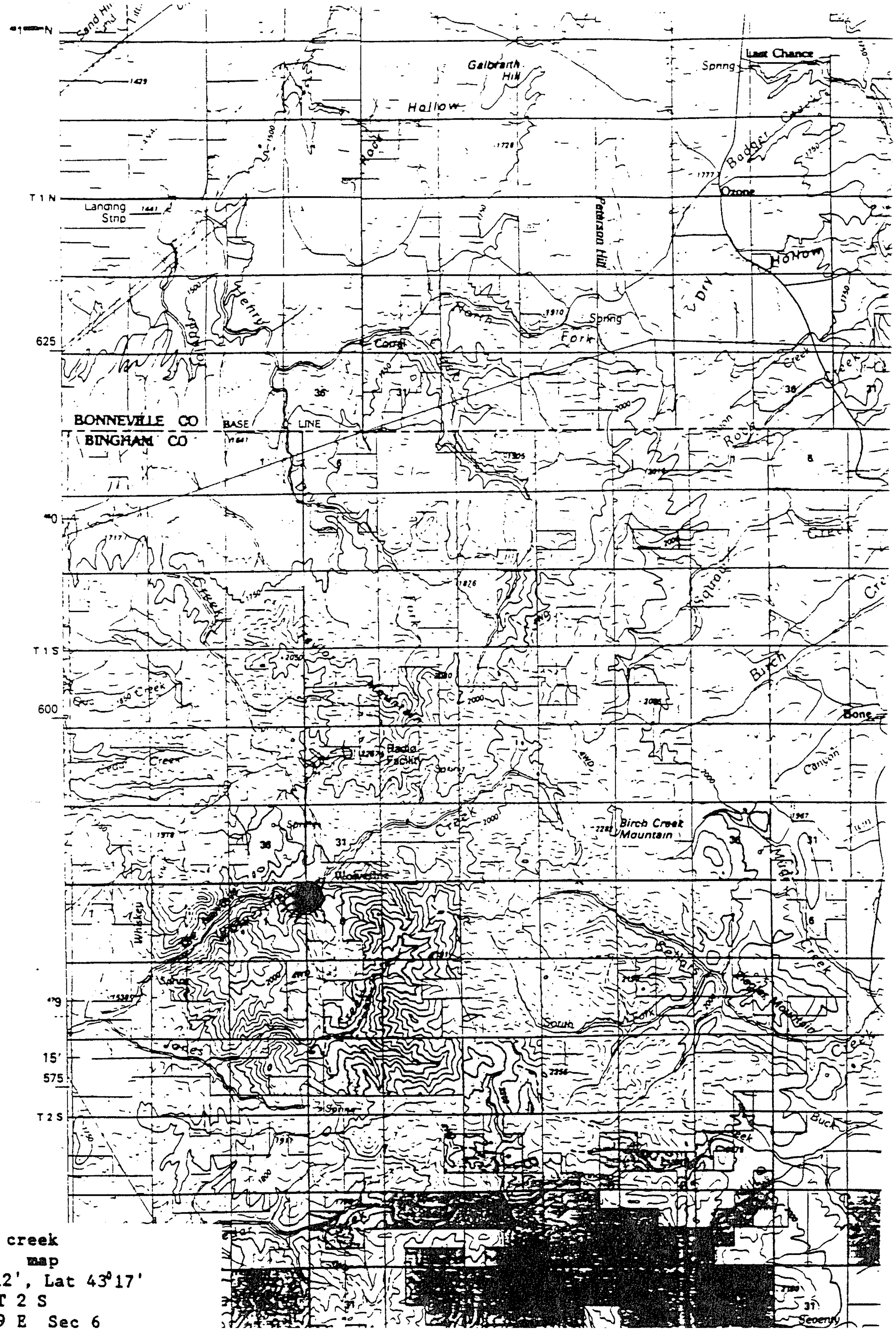
N4200-W11400/30x60

1978

SURFACE MANAGEMENT ST

Trapper creek
Rogerson Quadrangle
Long 114°06', Lat 42°08'
Township T 15 S

Trapper creek
Rogerson Quadrangle
Long 114°02', Lat 42°09'
Township T 15 S



Wolverine creek
Palisades map
Long 111°12', Lat 43°17'
Township T 2 S
Range R 39 E Sec 6

Appendix B. Standardized coefficients for canonical variables from the Multiple Discriminant Analysis results of the habitat measures.

Variable	Root 1	Root 2
Bank Stability	-.962	.024
Canopy Cover	.706	-1.658
Specific Conductance	.796	-.698
Discharge	.707	-.698
Stream Cover	-1.228	-.027
pH	-1.016	.426
Chlorophyll a	.506	.283
Measured Width:Depth Ratio	-1.222	.225
Pool:Riffle Ratio	.710	.436
Temperature	.209	.107
Width:Depth Ratio	.419	.326
Slope	.058	.202
Periphyton AFDM	.277	.293
% Cover	-.117	.720
Embeddedness	-.254	-1.343
Orthophosphate	-1.154	1.817
Nitrate	-1.062	.958
Substrate Size	1.388	.412
Eigenvalues	63.22	11.62
Percent explained	84.48	99.99

Appendix C. Standardized coefficients for canonical variables from the Multiple Discriminant Analysis results of the macroinvertebrate metrics data.

Variable	Root 1	Root 2
EPT/Ch+O	-.078	.575
Species Richness	.470	.105
EPT Richness	-.837	.904
Hilsenhoff Biotic Index	.834	-.077
Biotic Condition Index	-.154	-.113
EPT/C	-.742	-.169
% Dominance	-.894	-1.580
Shannon's Diversity (H')	-.521	-1.342
Simpson's Index	.695	1.003
S/F Ratio	.065	.098
% Scrapers	-.575	-.003
% Filterers	.598	.471
% Shredders	-.506	-.129
% EPT Taxa	2.069	.503
% Ch+O	.229	.681
% Chironomidae	-.262	-.206
Eigenvalues	3.83	.84
Percent explained	81.93	99.99

Appendix D. Standardized coefficients for canonical variables from Multiple Discriminant Analysis results of the macroinvertebrate taxa data.

Variable	Root 1	Root 2
Chironomidae	-.12998	.63433
Oligochaeta	.26237	-.14231
Baetis bicaudatus	-.64081	-.75823
Tricorythodes	.18580	-.56456
Hyallela azteca	.06326	.16939
Rhizelmis	2.12111	.97069
Hydracarina	-.67259	-.49579
Zapada	.27475	-.24929
Paraleptophlebia	-.05628	-.25037
Ostracoda	-.54382	.36370
Cinygmula	.50531	-.47462
Turbellaria	.49857	.85182
Epeorus albertae	-.33950	-.22748
Simulium	.71450	.05444
Hydropsyche	.33869	-.50633
Brachycentrus	-.11112	.01440
Ryacophila acroped	.48433	.03101
Pisidium	1.00642	.77338
Drunella coloraden	.43908	-.00327
Seratella tibiali	-.02954	-.16916
Ryacophila acroped	.62982	.45877
Glossosoma	-.59205	.38426
Heterlimnius	.28337	-.16549
Ameletus	-.19966	.22382
Ephemerella	-1.17913	-.87037
Ceratopogonidae	.01922	.38797
Clostocea	-.09746	1.18323
Alloperla	.88788	.90066
Hexatoma	.91045	.94014
Optioservus	-.09785	.51040
Antocha	-.12835	.77781
Eigenvalues	6.22	3.87
Percent explained	61.63	99.99

Appendix E. Absolute abundances of macroinvertebrates collected from each site. Qual.=qualitative sample; Quan.=quantitative sample.

SITE LOCATION	IM	Sp	Im	Sp	Up	Up	Im	Im	Im	Im	Im	Up	Lo	Sp	Up	Up	Lo	Lo
STATION #	29	24	30	23	4	1	28	26	31	32	27	8	15	20	3	2	19	18
DATE	900720	900718	900815	900619	900620	900614	900618	900620	900621	900619	900619	900717	900721	900718	900615	900614	900613	900613
REP #	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.
PREDATORS																		
Carabidae												1	1					
Alloperla																1	3	1
Atherix variagata									5									
Beloneuria															2			
Calineuria						5							5					
Chloroperlidae																		
Ceratopogonidae				3			2	7				1						
Claassenia											3							
Cordulegaster																		
Decapoda											1							
Dicronota					1		1										4	
Dytiscidae	10														1			
Empididae						2	2											
Gerridae																		
Glutops sp.																		
Hesperoperla pacifica					8													
Hexatoma											5						1	20
Hydracarina	1		63	11	1	3	12	2		6	1		4	6	4		18	15
Isoperla sp.																		
Limnophila																		
Nematoda				3		2		6							2			
Oreodytes			1		2													
Perlodidae																		
Planariidae																		
Setvena bradleyi																		
Skwala	1										9							
Staphylinidae																		
Suwallia sp.																		
Rhyacophila																		
Rhyacophila angelita																		
Rhyacophila hyalinata					1	2	18					2						
Rhyacophila vaccua																		
Rhyacophila vagrita																		
Rhyacophila verrula																		
Rhyacophila vespula																		
Rhyacophila coloradensis																		
Tipulidae																		
Calopteryx																		
Psephenidae									3		5		1					
Turbellaria			2			14				1								2
Yugus																	1	7
Naucoridae										2								
Cascadoperla								15										
Ophiogomphus	1			9				3	28		5							
Coenagrionidae	2																	
Sialis											8		1					
Amphiagrion											3							
Argia		6								5								
Hirudinidae	1										1							
Corixidae	2																	
GATHERERS																		
Ameletus sp.																		
Ameletus cooki																		
Ameletus similor																		
Ameletus velox						1												
Amiocentrus					4													
Antocha				1							4	8	16		2		3	2
Chelifera sp.																		
Cleptelmis sp.																		
Dixa		1																
Elmidae																		
Dubiraphia										19								
Rhizelmis	4		5	31	91		60		44						166	6	5	31
Hemerodromia		2		1					5					4				
Ephemerella										33								

Appendix E. Absolute abundances of macroinvertebrates collected from each site. Qual.=qualitative sample; Quan.=quantitative sample.

SITE LOCATION	IM	Sp	Im	Sp	Up	Up	Im	Im	Im	Im	Im	Up	Lo	Sp	Up	Up	Lo	Lo
STATION #	29	24	30	23	4	1	28	26	31	32	27	8	15	20	3	2	19	18
DATE	900720	900718	900815	900619	900620	900614	900618	900620	900621	900619	900619	900717	900721	900718	900615	900614	900613	900613
REP #	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.
Ephemerella aurivilli									6									
Ephemerella grandis																		
Ephemerella infrequens																		
Ptychoptera																		
Heterlimnius						1		5				122		2				
Hyallela azteca	10	169		5						6				36	8	1	18	64
Crinitis	1																	
Lara sp.																		
Lepidostoma		5	3															
Leptophlebia	1																	
Narpus sp.																		
Stratiomyidae																		
Tabanidae																		
Tipula sp.																		
Optioservus											35							
Odontyomyia																		
Paraleptophlebia			42								14	1	7					
Pericoma														4				
Polycentropus			1															
Ryacophila acropedes						6												
Serratella tibialis						9												
Zaitzevia				2														
Tricorythodes	11			127				2	1	9	24	2	5					
Gonielmis			1			13				21			44					
Stenelmis													20					
Moselyana	3														1			
Caenis	20																	
Stenelmis	2																	
SCRAPERS																		
Baetis bicaudatus														10	56	3		
Baetis intermedius	23	5	7		57	22	16	15	78	34							89	12
Baetis tricaudatus				13							6	10						
Cinygmula			5			59												
Drunella coloradensis																		
Drunella doddsi						6												
Drunella flavilinea						20												
Drunella spinifera																		
Epeorus sp.																		
Epeorus deceptivus																		
Epeorus iron																3		
Epeorus longimanus					59	35	1											
Epeorus albertae										3	27		3					
Ephemerella inermis							16		1						12	3	27	41
Fluminicola virens																		
Gastropoda																		2
Glossosoma						3	1				6	11	21					
Heptageniidae		1						3	1		5				4	2		1
Hydroptila	13	2	64					6					1	10				
Helicopsyche	3						1			1			1		4			
Neothremma sp.																		
Neophylax						3												
Oligophlebodes sp.																		
Blephariceridae																		
Pyralidae																		
Rhithrogena						3												
Stenonema sp.																		
Caudatella heterocaudata					12							1						
SHREDDERS																		
Acentria																		
Capnia						3												
Clostocea sp.																		
Ephemerella infrequens																		
Limnephilidae		5				2	1			3		5						
Micrasema					3	3									3			
Onocosmoecus sp.																		
Psychoglypha																	22	1
Pteronarcys californica									18			7			4			

Appendix E. Absolute abundances of macroinvertebrates collected from each site. Qual.=qualitative sample; Quan.=quantitative sample.

SITE LOCATION	Up	Lo	Lo	Sp	Sp	IM	Lo	Lo	Lo	Lo	Lo	Up	Up	Im	Im	Up	Up	Im	Im
STATION #	5	17	16	22	21	54	48	48	47	46	45	39	39	51	51	37	37	49	49
DATE	900614	900826	900825	900825	900830	900815	910625	910625	910622	910621	910624	910624	910624	910623	910623	910627	910627	910627	910627
REP #	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAN.	QUAN.	QUAL.	QUAN.	QUAN.	QUAN.	QUAN.	QUAL.	QUAN.	QUAL.	QUAN.	QUAL.	QUAN.	QUAL.
PREDATORS																			
Carabidae		1			1												1		
Alloperla	1	4										10	47			2			
Atherix variagata																			
Beloneuria																			
Calineuria		4					12	11			5		3						
Chloroperlidae												3							1
Ceratopogonidae		1					1	2	17	1		8							
Claasenia																			
Cordulegaster											1								
Decapoda																			
Dicronota			1				5	2			4					2			
Dytiscidae		1													1			5	15
Empididae																			
Gerridae		1																	
Glutops sp.																			
Hesperoperla pacifica																	3		
Hexatoma			6				2			45	47	1	3		1				
Hydracarina		1	10	14	13		2	8		19		2			1	11	2		
Isoperla sp.													5						
Limnophila	1																		
Nematoda	3						5		1	3	2	2		1		2		1	
Oreodytes																			
Perlodidae																			
Planariidae						5													
Setvena bradleyi																			
Skwala		10	2							8									
Staphylinidae										2						1			
Suwallia sp.											3								
Rhyacophila																			
Rhyacophila angelita													2						
Rhyacophila hyalinata	1									8									
Rhyacophila vaccua																			
Rhyacophila vagrita																1			
Rhyacophila verrula																			
Rhyacophila vespula																			
Rhyacophila coloradensis												1	1						
Tipulidae			2							1									
Calopteryx			1																
Psephenidae																			
Turbellaria	4				140						1					7	3		
Yugus																			
Naucoridae																			
Cascadoperla																			
Ophiogomphus			11																
Coenagrionidae																			
Sialis		3	7				4	5	51										
Amphiagrion																			
Argia			4																
Hirudinidae																			
Corixidae			1	2			5	5							2				2
GATHERERS																			
Ameletus sp.																3	1		1
Ameletus cooki														52	80				
Ameletus similor																			
Ameletus velox							10	3	11										
Amiocentrus						1													
Antocha			5		3					7							1		
Chelifera sp.																	2		
Cleptelmis sp.																	1		
Dixa																			
Elmidae														1					
Dubiraphia		6	2																
Rhizelmis	33																		
Hemerodromia			1	5				5	2										7
Ephemerella																			

Appendix E. Absolute abundances of macroinvertebrates collected from each site. Qual.=qualitative sample; Quan.=quantitative sample.

SITE LOCATION	IM	Sp	Im	Sp	Up	Up	Im	Im	Im	Im	Im	Up	Lo	Sp	Up	Up	Lo	Lo
STATION #	29	24	30	23	4	1	28	26	31	32	27	8	15	20	3	2	19	18
DATE	900720	900718	900815	900619	900620	900614	900618	900620	900621	900619	900619	900717	900721	900718	900615	900614	900613	900613
REP #	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.
Zapada sp.																		
Zapada cinctipes	1		5			1						3						
Zapada oregonesis		4											25			1		
Paracapnia						1												
Grensia													24		3			
Dicosmoecus										14								
Chyranda				3														
Amphineumura																	6	
Yoroperla brevis																		
FILTERERS																		
Arctopsyche	37	1				1												
Brachycentrus					1	3	10		60						8	1	5	51
Hydropsyche				22	2		16	1	2	31	59	34	8					
Nectopsyche																		
Ostracoda		5	32	1					3	2			9		6		32	22
Parapsyche elis						3												
Pisidium		6		8	1					24		16			2		34	5
Simulium		1		6	3	41	4	136	4	6					4		8	
Prosimulium					13											286		6
Physa	5	1	5	6				1		11								
Gyraulus										8								
MINERS																		
Chironomidae	110	22	38	35	18	25	84	79	14	32	58	47	57	243	3	4	6	57
Oligochaeta	29	6	3	3		1	12	3	3	11	7	2	9	13	1		30	6
Eubranchiopoda	1																	
Hymenoptera							3	1	1	1								
Diptera						2												
Tubifex																		
MISCELLANEOUS																		
Homoptera																		
Fontelicella																		
Clinocera																		
Phychodidae																		
Hydrobius sp.																		

Appendix E. Absolute abundances of macroinvertebrates collected from each site. Qual.=qualitative sample; Quan.=quantitative sample.

SITE LOCATION	Up	Lo	Lo	Sp	Sp	IM	Lo	Lo	Lo	Lo	Lo	Up	Up	Im	Im	Up	Up	Im	Im
STATION #	5	17	16	22	21	54	48	48	47	46	45	39	39	51	51	37	37	49	49
DATE	900614	900826	900825	900825	900830	900815	910625	910625	910622	910621	910624	910624	910624	910623	910623	910627	910627	910627	910627
REP #	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAN.	QUAN.	QUAL.	QUAN.	QUAN.	QUAN.	QUAN.	QUAL.	QUAN.	QUAL.	QUAN.	QUAL.	QUAN.	QUAL.
Ephemerella aurivilli																			
Ephemerella grandis	2																		
Ephemerella infrequens											5								
Ptychoptera																			
Heterlimnius							30	24			13	1	2			68	18	21	
Hyallela azteca				64		2						1			2				2
Crinitis																			
Lara sp.													1						
Lepidostoma																			
Leptophlebia																			
Narpus sp.													1						
Stratiomyidae															4				
Tabanidae											4								
Tipula sp.																1			
Optioservus		40	62			1				37						12	2	1	6
Odontyomyia																			
Paraleptophlebia							15	4		1	9					5	10		2
Pericoma					1														
Polycentropus																			
Ryacophila acropedes		2											4			9	16		14
Serratella tibialis										1						1	1		
Zaitzevia																			
Tricorythodes			19	21			28	70				1		109	141				
Gonielmis					7														
Stenelmis																			
Moselyana																			
Caenis																			
Stenelmis																			
SCRAPERS																			
Baetis bicaudatus					13					49	25	10	59	2		7	32	82	191
Baetis intermedius	40	65	2																
Baetis tricaudatus						1													
Cinygmula	20	1						9				15	17		2	37	5	20	15
Drunella coloradensis					1			1			1	9	5			1	17		
Drunella doddsi	6											1	8			3	2		
Drunella flavilinea																			
Drunella spinifera													1						
Epeorus sp.																			
Epeorus deceptivus																			
Epeorus iron																			
Epeorus longimanus	8											1	86			8	19	1	
Epeorus albertae		7	4							10	2								
Ephemerella inermis	10												3						
Fluminicola virens						15													
Gastropoda																			
Glossosoma		15	1	2							10								
Heptageniidae							15												
Hydroptila		7		43															
Helicopsyche			4			1				1	8								
Neothremma sp.												1	1			2	2		
Neophylax	2						3												
Oligophlebodes sp.												6							
Blephariceridae			2																
Pyralidae			2		1														
Rhithrogena												1	2			2			
Stenonema sp.																			
Caudatella heterocaudata																			
SHREDDERS																			
Acentria																1	1		
Capnia																	2		
Clostocea sp.							15	48		1	3								
Ephemerella infrequens																1			
Limnephilidae		1	1	1												2	14		
Micrasema	12			6															
Onocosmoeus sp.							3			1	2								
Psychoglypha								1	2										
Pteronarcys californica																	1		2

Appendix E. Absolute abundances of macroinvertebrates collected from each site. Qual.=qualitative sample; Quan.=quantitative sample.

SITE LOCATION	Up	Lo	Lo	Sp	Sp	IM	Lo	Lo	Lo	Lo	Lo	Up	Up	Im	Im	Up	Up	Im	Im
STATION #	5	17	16	22	21	54	48	48	47	46	45	39	39	51	51	37	37	49	49
DATE	900614	900826	900825	900825	900830	900815	910625	910625	910622	910621	910624	910624	910624	910623	910623	910627	910627	910627	910627
REP #	QUAL.	QUAL.	QUAL.	QUAL.	QUAL.	QUAN.	QUAN.	QUAL.	QUAN.	QUAN.	QUAN.	QUAN.	QUAL.	QUAN.	QUAL.	QUAN.	QUAL.	QUAN.	QUAL.
Zapada sp.													1						
Zapada cinctipes	2															14	34		
Zapada oregonesis		41			3														
Paracapnia																			
Grensia	4		5	3															
Dicosmoecus										1									
Chyranda																			
Amphineumura																			
Yoroperla brevis																			
FILTERERS																			
Arctopsyche	2											1	5						
Brachycentrus	4		4			19				13	14		1	2	6				
Hydropsyche	21	4	4			9	10	3		1									
Nectopsyche						2													
Ostracoda					1									12					
Parapsyche elis																	1		
Pisidium	4	2	1	4	1	3										9			
Simulium	1	2			6	2				1			2	27	8		1	4	7
Prosimulium																			
Physa				20															
Gyraulus			3																
MINERS																			
Chironomidae	104	93	113	105	12	28	134	112	266	63	55	5	1	53	12	22	39	124	23
Oligochaeta		10	9	3	79		40		34		33	196	11	100	40	6	8	175	14
Eubranchiopoda																			
Hymenoptera																			
Diptera																			
Tubifex						11													
MISCELLANEOUS																			
Homoptera			1	3															
Fontelicella						876													
Clinocera										10	10								
Phychodidae																		1	
Hydrobius sp.																			

Appendix E. Absolute abundances of macroinvertebrates collected from each site. Qual.=qualitative sample; Quan.=quantitative sample.

SITE LOCATION	Im	Im	Im	Im	Im	Up	Im	Up	Lo	Up	Up	Up	Up	Up	Up	Up
STATION #	53	53	52	52	50	36	50	35	44	43	43	40	40	38	41	42
DATE	910623	910623	910623	910623	910628	910629	910628	910629	910624	910801	910801	910801	910801	910829	910830	910830
REP #	QUAN.	QUAL.	QUAN.	QUAL.	QUAL.	QUAN.	QUAN.	QUAN.	QUAN.	QUAL.	QUAN.	QUAL.	QUAN.	QUAN.	QUAN.	QUAN.
PREDATORS																
Carabidae																
Alloperla	1	1	1							8	7	12	31	11	3	6
Atherix variagata																
Beloneuria																
Calineuria									17			11	1		8	
Chloroperlidae			1	1									2			
Ceratopogonidae	1			2							1					
Claassenia																
Cordulegaster																
Decapoda																
Dicronota	3	1							1							
Dytiscidae																
Empididae						1										
Gerridae							2									
Glutops sp.								1		1	1			5		2
Hesperoperla pacifica					1	2	6	1						4		
Hexatoma	1		17	41	20	1	8	1	7	4	2	5	3	2	6	
Hydracarina	1		1	2	2	3	2	4		10	7	1	4	48	9	
Isoperla sp.								1		1	10	3	1			1
Limnophila																
Nematoda	5		4	4			4		2	3	8		4	2		
Oreodytes																
Perlodidae									1							
Planariidae																
Setvena bradleyi																7
Skwala																
Staphylinidae							1				1					
Suwallia sp.				1												
Rhyacophila						1	2	2						2		2
Rhyacophila angelita											1	1		11	12	4
Rhyacophila hyalinata						5						6				1
Rhyacophila vaccua										3	7	3	3			
Rhyacophila vagrita				1											4	
Rhyacophila verrula											2					
Rhyacophila vespula										2	5	1		1		4
Rhyacophila coloradensis																
Tipulidae										1				1		
Calopteryx																
Psephenidae																
Turbellaria			2		1	11		22	7	6	2	2	2	8	7	17
Yugus																
Naucoridae																
Cascadoperla																
Ophiogomphus				4					1							
Coenagrionidae																
Sialis																
Amphiagrion						2		31								
Argia																
Hirudinidae																
Corixidae				1												
GATHERERS																
Ameletus sp.		1								2	3		3		1	
Ameletus cooki																
Ameletus similor														6		
Ameletus velox																
Amiocentrus																
Antocha			4		9	31		2	28							
Chelifera sp.									1							2
Cleptelmis sp.																
Dixa																
Elmidae																
Dubiraphia																
Rhizelmis																
Hemerodromia										4		2	1		2	
Ephemerella																

Appendix E. Absolute abundances of macroinvertebrates collected from each site. Qual.=qualitative sample; Quan.=quantitative sample.

SITE LOCATION	Im	Im	Im	Im	Im	Up	Im	Up	Lo	Up	Up	Up	Up	Up	Up	Up
STATION #	53	53	52	52	50	36	50	35	44	43	43	40	40	38	41	42
DATE	910623	910623	910623	910623	910628	910629	910628	910629	910624	910801	910801	910801	910801	910829	910830	910830
REP #	QUAN.	QUAL.	QUAN.	QUAL.	QUAL.	QUAN.	QUAN.	QUAN.	QUAN.	QUAL.	QUAN.	QUAL.	QUAN.	QUAN.	QUAN.	QUAN.
Ephemerella aurivilli			8	6						5						
Ephemerella grandis																
Ephemerella infrequens																
Ptychoptera	1															
Heterlimnius			4		18	6	1	50	160	6	7		6	1	1	4
Hyallela azteca																
Crinitis																
Lara sp.																
Lepidostoma																
Leptophlebia																
Narpus sp.																
Stratiomyidae																
Tabanidae																
Tipula sp.							14									
Optioservus	30	62		5												
Odontyomyia					1				1							
Paraleptophlebia			2						5						2	
Pericoma														24		
Polycentropus			1			14			15							
Ryacophila acropedes						4	1	2		4		3	3	14	4	1
Serratella tibialis					3	2	5			6	25	2	12			
Zaitzevia																
Tricorythodes									1							
Gonielmis																
Stenelmis																
Moselyana																
Caenis																
Stenelmis																
SCRAPERS																
Baetis bicaudatus	161	74	149	208		61		76	35					37	4	31
Baetis intermedius					152		219			78	14	32	26			
Baetis tricaudatus																
Cinygmula			19	17	2	84		82		25	50	38	40	40	5	
Drunella coloradensis			1			22					1	8				3
Drunella doddsi						11				1		25	2	2	24	7
Drunella flavilinea																
Drunella spinifera										5					1	
Epeorus sp.											6					
Epeorus deceptivus																10
Epeorus iron												25	12			
Epeorus longimanus					11	24										
Epeorus albertae																
Ephemerella inermis										1						
Fluminicola virens																
Gastropoda																
Glossosoma	3	1											1			
Heptageniidae																
Hydroptila				3												
Helicopsyche			1	1												
Neothremma sp.								15								6
Neophylax																
Oligophlebodes sp.						1		1								
Blephariceridae																
Pyralidae																
Rhithrogena									5						10	7
Stenonema sp.															18	
Caudatella heterocaudata																
SHREDDERS																
Acentria									1							
Capnia									2	2	1			43	6	3
Clostocea sp.					2											
Ephemerella infrequens															1	2
Limnephilidae																
Micrasema										1	1	3				
Onocosmoeus sp.							1									
Psychoglypha																
Pteronarcys californica		1														

Appendix E. Absolute abundances of macroinvertebrates collected from each site. Qual.=qualitative sample; Quan.=quantitative sample.

SITE LOCATION	Im	Im	Im	Im	Im	Up	Im	Up	Lo	Up	Up	Up	Up	Up	Up	Up
STATION #	53	53	52	52	50	36	50	35	44	43	43	40	40	38	41	42
DATE	910623	910623	910623	910623	910628	910629	910628	910629	910624	910801	910801	910801	910801	910829	910830	910830
REP #	QUAN.	QUAL.	QUAN.	QUAL.	QUAL.	QUAN.	QUAN.	QUAN.	QUAN.	QUAL.	QUAN.	QUAL.	QUAN.	QUAN.	QUAN.	QUAN.
Zapada sp.																
Zapada cinctipes																
Zapada oregonesis	29	17				5		7		10	8	20	16	6	15	4
Paracapnia																
Grensia																
Dicosmoecus							1			2						
Chyranda																
Amphineumura																
Yoroperla brevis				1												2
FILTERERS																
Arctopsyche																
Brachycentrus			1		6	7	13						1			
Hydropsyche					30	5	27		13							
Nectopsyche																
Ostracoda																
Parapsyche elis	3	8								12	5	9	5		28	3
Pisidium																
Simulium	108	142	4	3	5	3	3	2		8	3	12				
Prosimulium																
Physa					1											
Gyraulus																
MINERS																
Chironomidae			61	22	91	11	7	15	56	67	94	16	86	21	52	
Oligochaeta	14	6	6		11	12	1	3	10	10	24	27	51	44	76	126
Eubranchiopoda																
Hymenoptera																
Diptera																
Tubifex																
MISCELLANEOUS																
Homoptera																
Fontelicella																
Clinocera																
Phychodidae																
Hydrobius sp.			1	2												

Appendix F. Species names for macroinvertebrate notations in Tables 10 and 11.

Species name	Notation
Cinygmula	CINYG
Simulium	SIMU
Epeorus	EPEO
Chironomidae	CHIR
Baetis	BAET
Drunella coloradensis	DRCO
Turbellaria	TURB
Elmidae	ELMI
Serratella tibialis	SETI
Drunella doddsi	DRDO
Rhyacophila acropedes	RHAC
Calineuria	CALI
Capnia	CAPN
Micrasema	MICR
Brachycentrus	BRAC
Oligochaeta	OLIG
Parapsyche elis	PAEL
Rhithrogena	RHIT
Hydracarina	HYDRA
Glossosoma	GLOS
Rhyacophila	RHYA
Zapada	ZAPA
Arctopsyche	ARCT
Heterlimnius	HETE
Ameletus	AMEL
Hydropsyche	HYDRO
Ephemerella	EPHE
Pisidium	PISI
Grensia	GREN
Alloperla	ALLO
Hexatoma	HEXA
Paraleptophlebia	PARA
Ceratopogonidae	CERA
Hyallela azteca	HYAL
Tricorythodes	TRIC
Amphiagrion	AMPH
Antocha	ANTO
Hydroptila	HDROP
Ostracoda	OSTR
Clostoeca	CLOS
Optioservus	OPTI
Sialis	SIAL
Pteronarcys californica	PTCA
Ophiogomphus	OPHI
Fontelicella	FONT